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THE JOURNAL OF TUBERCULOSIS

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ORIGINAL CONTRIBUTIONS.

THE DEVELOPMENT OF TUBERCULOSIS IN THE INDIVIDUAL WITH SOME REMARKS ON THE TUBERCLE BACILLUS AND CERTAIN ALLIED FORMS OF BACILLI.*

BY H. EDWIN LEWIS, M. D., BURLINGTON, VT.

Philanthrophy properly concerns itself with the afflictions of the multitude, but the humanitarianism of true medical science prescribes that its usefulness should begin with a consideration of disease as it affects the unit of society—the individual.

The medical profession, owing its existence to the needs of individual mankind, should therefore in the study of tuberculosis preface all consideration of the disease by a due investigation of the factors and changes involved in the development of tuberculous conditions in the individual.

The pessimist in retrospection finds small results from the labors of those great students who have devoted their lives and their fortunes to the study of the disease. He is prone to claim that the slight lowering of the death rate from tuberculosis during the last decade has resulted solely from greater accuracy in diagnosis and a universal tendency towards decrease of the general mortality rate.

But the optimist, God bless him! sees in the priceless labors of Buehl, Villemin, Cohnheim, Klebs, Koch, Virchow, Roux, Dieulafoy and countless other toilers in the field of experimental medicine, great promise for the future. From statistics and clinical observation he recognizes the assailability of tuberculosis through hygienic and sanitary measures, and from the post mortem table he is awakening to the

*Read in part at the Joint Meeting of the American Congress of Tuberculosis and the Medico-Legal Society, May 15 and 16, 1901.

significant fact that tuberculous lesions are non-fatal in a fair majority of instances. On every hand, therefore, he sees abundant signs to foster the hope—yea, the confident expectation that sooner or later the treatment of tuberculosis will be as specifically defined as that of syphilis, diphtheria or malaria.

But thinking men, honest in every sense of the word, realize that the facts essential to the ultimate conquest of tuberculosis lie behind the phenomena which occur when the tubercle bacillus enters the living organism—and perhaps before. More plainly expressed the successful treatment and cure of tuberculous conditions must be based on a more accurate knowledge of the infective agent and the development and progress of its characteristic lesions in the human body.

For years the hereditary factor in the development of tuberculosis has been held of great importance. But latter day investigation and more intimate knowledge of cause and effect has modified the theory of heredity to a marked degree. Today we know that direct transmission of tuberculosis from parents to offspring is a rare occurrence and never takes place except by infection during prenatal life through the maternal blood supply to the foetus. This, then, is the only tenable remnant of the theory of direct hereditary transmission of the disease.

We do recognize, however, the possibility of handing down certain stigmata of degeneration; not necessarily to the extent of physical characteristics, like marked increase or decrease of the cephalic index or changes in the helix of the ear, the teeth, the palatal vault, mental conditions, etc., but in certain histologic depreciations in the vitality and resistance of the cellular structures. Briefly stated, this theory, which has ample verification in clinical experience, is that any disease or degenerative change which vitiates the parental cellular elements may give rise to degenerative tendencies in similar histologic structures of the offspring, thus increasing susceptibility to any disease. The lymphatic system probably shows the influence of hereditary vitiation more often than any other body-tissue, and since the rise or fall of this particular portion of the human organism has the greatest influence on the develpment of tuberculosis, as I will endeavor to show later on, we can readily understand how easy it has been in the past to superficially consider pulmonary tuberculosis a hereditary disease.

Of 176 cases of tuberculous phthisis I have been able to collect reliable data from, and whose family history I have been able to trace back two generations, I have found tuberculosis or other respiratory disease that might have been tuberculous in only 71 parents or grandparents of 42 cases.

The following table of diseases that either caused death or prominently occurred in the parents or grandparents of the above 176 cases of pulmonary tuberculosis is interesting:

Tuberculous phthisis or other disease that might have been tuberculous	71
Epilepsy	16
Apoplexy	46
Bright's disease	39
Cancer or malignant growths	60
Heart disease	148
Insanity	28
Chronic alcoholism	84
Diabetes	14
Syphilis	11
Miscellaneous diseases of chronic character	157
Negative history of chronic ailment	382
Total parents and grandparents	1056

From the foregoing it would seem fairly evident that the hereditary rôle of pulmonary tuberculosis is hardly so important a factor in the development of the disease as has been claimed in the past. It would also seem to have no more causative bearing on the production of a fertile soil than many other chronic ailments tending to histologic vitiation.

Another premise that should modify statistics of heredity is the fact that the offspring of tuberculous parents are much more exposed to infection from the intimacy of family relations, hence acquirement of the disease in many seemingly hereditary cases must be attributed, not to hereditary, but to direct infection.

The discovery of the specific germ of tuberculosis in 1882 cleared up many mooted points in regard to the disease. The infectiousness of tuberculous material had long been recognized but the exact agent was unknown. Koch's discovery settled the matter once and for all, and medical science profited wonderfully as a consequence of the marked impetus given the study of bacteriology.

The recognition of a definite causative agent, more or less constant in its results, stimulated further research of tuberculous phenomena, and with the advent of more accurate information many old theories were proven fallacious. The doctrine of heredity sank back to an unimportant place, and close clinical observers awoke to the fact that while tubercle bacilli were the cause of tuberculosis certain other factors

modified their pathogenic action. In other words certain conditions of the human organism must be favorable to the growth and perpetuation of the tubercle bacillus or the disease is not produced—that is, the soil must be adapted to the seed. It seems to me that study of this question will bring us very close to the correct solution of all the varied problems presented by the development or non-development of tuberculous lesions.

But first we must study the seed. What factors or conditions increase or decrease virulence of tubercle bacilli? The answer to this question is as yet unknown, but there is abundant proof to indicate that tubercle bacilli do show variation in pathogenic intensity. Thus bacilli from manifest disease in the cow, the horse or in man are markedly different in their degree of virulence as shown by the expements of Theobald Smith.[1] Likewise tubercle bacilli from different lesions in the human body also show decided pathogenic variation. The experiments of Arloing and Lingard conclusively indicate this fact, for they have demonstrated that tuberculous material from lesions in the lungs killed guinea pigs and rabbits much quicker than that taken from caseous glands or other parts of the body.

Every observer of clinical phenomena recognizes variations in the progress and duration of tuberculous processes in general, but more particularly of those occurring in the lung. Such variations may, it is true, result from special susceptibility of the infected tissue in many instances, but in many others there are abundant signs to point to a varying degree of virulence of the infective material. One class of cases may begin abruptly in individuals comparatively robust and give rise to all the symptoms of an acute pneumonic process, constituting the well-known "galloping consumption," or "phthisis florida," which frequently proves fatal in four to eight weeks. In still another class of cases composed of individuals recognized as physically weak, the tuberculous condition may be so insidious in onset and with a prodromal stage so protracted that the distinct lesions of the disease cannot be defined until far advanced. Periods of seeming resolution and recovery may occur and yet the patient finally succumb years after the initial onset of the disease. As I have previously said, the natural deduction from these two types of the same disease is that they owe their varience to different degrees of susceptibility of the individual. In a measure this may be true in every case. Certainly we cannot controvert such a deduction for we have no means of guaging vital resistance. But I have been able to demonstrate that infective material

[1]Journal of Boston Society of Med. Science, 1900, iv., 95.

from widely different types of pulmonary tuberculosis does show marked variation in virulence for the lower animals. My experiments, while not so complete nor so skillfully conducted as might have been possible in a well equipped laboratory, were in part as follows:

One group of five guinea pigs and four rabbits, after aseptic preparation, were inoculated with sputum from two cases of rapidly fatal acute pneumonic phthisis; and a second group with sputum from two chronic cases, both of over one year's duration, but with slight invasion of the lung substance. Of the first group, the guinea pigs all showed extensive lesions in five to fourteen days, and all but one died inside of eight weeks. All of the rabbits also showed comparatively rapid extension of the tuberculous infection, but the results in the second group were quite different. In the same number of animals the extension of the disease from the inoculated area was delayed two or three times as long, and only one of the guinea pigs died within three months. Of the second group of rabbits only two gave any reaction to the inoculations whatsoever.

The quantity of tubercle bacilli in the specimens of sputum used did not enter into the result, for the comparative number of bacilli, judged from seven or eight microscopic slides, was greater in one of the chronic cases than in both of the acute and rapidly fatal ones. The Vermont state bacteriologist confirmed this fact, reporting for the same specimens of sputum that the number of bacilli in both of the acute and in one of the chronic cases was "moderate" while in the other chronic case the bacilli were "numerous."

Again, it is my belief that the tubercle bacilli found in late stages of pulmonary tuberculosis are more virulent than those found at the onset. To adequately prove this the necessary experiments will have to extend over long periods, and though I have several such under investigation, I have not as yet been able to accumulate sufficient evidence to prove my belief. However, during the progress of my experiments, I have obtained one or two striking results.

A little over two and one-half years ago I inoculated three rabbits with sputum from a case of early but positive pulmonary tuberculosis. The tubercle bacilli were easily demonstrable in the sputum. All of the rabbits showed characteristic lymphatic enlargement after several weeks, but when killed and examined three months later only one gave indications of advanced pulmonary tuberculosis or of general involvement. The case from whom the sputum used was obtained drifted out of my sight and I did not see him again for one year and nine months, when he again applied to me for treatment. His disease had been

progressive and he was evidently in the last stages. Both lungs were extensively involved, as was the larynx. Expectoration was profuse, but did not contain relatively any more bacilli than the sputum obtained at the first examination. I inoculated several rabbits and was astonished at the reaction produced. The point of inoculation in all of the rabbits in from four to twelve days showed marked evidence of suppuration and extension to the lymphatics. In two of the rabbits a zone of extensive ulceration occurred around the inoculated point. All of the animals were profoundly affected in contradistinction to those inoculated with the same man's sputum one year and nine months before. Indeed, the rabbits first experimented with were apparently not affected at all, for the lesion of inoculation healed in a few days and never amounted to more than a slight nodule that could be felt under the skin. Suppuration never took place.

I came to the conclusion that the second group of rabbits was suffering from a mixed or additional pyogenic infection, and considered that this nullified the experiment in so far as determining the relative virulence of bacilli in different stages of the disease was concerned. On the thirty-ninth day one of the rabbits died. Autopsy showed very evident tuberculous lesions in the lungs, kidneys, liver and mesenteric glands. I killed the other rabbits on the forty-fourth day, and they too gave gross evidence of tuberculous disease of glands, lungs, kidneys and other organs.

The fact, then, that of the first group of rabbits none should die, and only one after three months time give evidence of microscopic lesions, while of the second group one should die, and all show within two months such marked progress of the disease, certainly seems significant. Of course, I realize that this single experiment will not justify any hard and fast conclusions, but no one can deny that it is suggestive. Some reason must have existed to hasten or increase the pathogenic action of the tubercle bacilli from the last specimen of sputum. Whether it was the presence of the mixed infection or not I am not prepared to say. I am inclined to believe so, however, since certain experiments with the lower animals have demonstrated that some germs that alone are comparatively non-pathogenic to individual animals, become decidedly so when combined with certain others. For instance Roger found that when animals immune to malignant oedema were simultaneously injected with one to two c.c. of a culture of the bacillus prodigiosus and a culture of malignant oedema, they would speedily contract the disease. Giarre also found that adult guinea pigs, which ordinarily resist infection with the pneumococcus, succumb

readily to septicemia when pneumococci are combined with diphtheria bacilli.

Some observers, notably Sata and Ophuls[1], have been studying the presence of other bacteria in pulmonary tuberculosis, and their research and investigations point to the importance of mixed infection in producing the pathologic conditions and symptoms considered characteristic of the disease. It would seem that pulmonary tuberculosis is a pure tuberculosis only in the beginning, that advance of the disease is coincident with the establishment of a new factor which in itself is largely responsible for the destructive process, or else greatly augments the action of the tubercle bacilli.

Out of the twenty-seven cases of markedly progressive pulmonary tuberculosis whose sputum I have examined very carefully during the last three months, there was pronounced mixed infection in all but three cases. Streptococci were most evident in fourteen cases, staphylococci in four and pneumococci in six. The disease seemed to be most active in those cases of mixed streptococcic infection and was evidenced by high fever ranging over 102 degrees F., more profuse sweating and general exaggeration of the symptoms characteristic of profound toxaemia. In three cases of streptococcic infection I have been able to produce a decided remission of the fever and other toxaemic symptoms and to establish improvement, temporary at least, by the injection of 20 c. c. of anti-streptococcic serum. More extended study is needed on this subject, but from my own clinical and microscopic observations I am convinced that the fatal character and progress of pulmonary tuberculosis is invariably hastened, and may possibly be largely due to the presence of a secondary or mixed infection.

Another phase of the study of tubercle bacilli and their action is the investigation of certain pseudo-tuberculous conditions. Flexner[2] has described a pathologic condition characterized by a caseous pneumonia and a nodular condition of the peritoneum which he has called pseudo-tuberculosis-hominis-streptothrica. A streptothrix which was found in the lesions was very different from ordinary forms of tubercle bacilli or streptothrix. The fact that small branched forms of tubercle bacilli are occasionally found in tuberculous lesions resembling the actinomyces, to which the above streptothrix probably belongs, may show that these pseudo-forms of tuberculosis bear some relation to the real disease after all. The recent discovery of several acid-proof bacilli closely resembling the bacilli of tuberculosis in morphology and

[1]American Journal of Medical Sciences, 1900, cxx., 56.

[2]Journal of Experimental Medicine, 1898.

tinctorial peculiarity raises new conjecture concerning the pathogenic relation of these bacilli to the potent germ of tuberculosis. Just how strong parasitic tendencies these similar appearing bacilli possess is unknown, and such investigation offers an interesting and highly important field of study. New and startling facts are sure to be demonstrated, and the widespread existence of tuberculosis will be more readily accounted for when they are properly classified and recognized.

Moller[1] has recently described a grass bacillus which he found in barn dust. This germ forms rods in fluid media, and in its morphologic aspect closely resembles the tubercle bacillus. It is pathogenic to guinea pigs, the lesions being almost microscopically identical with those of true tuberculosis. Histologically the process also closely resembles tuberculosis. It is an interesting fact that Moller while studying this grass bacillus was taken ill with a sore throat, and in certain masses which he expectorated was able to demonstrate this germ. Marzinowsky in studying the bacterial contents of the tonsillar crypts found an acid-proof bacillus that greatly resembles the tubercle bacillus. It was fairly frequent in the follicles of the tonsils as he demonstrated it in five out of twelve cases. The bacillus is polymorphous and stains by the Gram, Ziehl-Gabbet methods. Marzinowsky found a similar bacillus in the sputum of a patient with bronchitis, and comparison of cultures showed it to be identical with the one found in the tonsils. Another bacillus that has been found in the sputum of patients with pulmonary gangrene, and described by Fraenkel, Cappenheim and Rabinowitsch, is very similar to the tubercle bacillus, although more constantly clubbed at one end and a trifle longer. It has all of the morphologic and staining peculiarities of the tubercle bacillus.

In the sputum of a case of acute bronchitis occurring in a robust dairyman I found, in addition to streptococci, a number of fairly long bacilli some of which were branched two or three times. Some appeared broken like a chain. These bacilli were acid-proof and alcohol-proof and stained well by the Ziehl-Gabbet method. Rabbits inoculated with this sputum showed suppuration at the point of inoculation and a lymphatic enlargement in three weeks. In shortly over a month in some caseous material taken from the peritoneal glands of these rabbits I was able to find the same bacillus, but in interwoven clumps. Those bacilli that were separated from these clumps were smaller and resembled tubercle bacilli closely, with the exception of being considerably thicker. The patient gave a history of having been

[1]Centralbl. f. Bakt., Abth. I., 1899, XXV., 369-373.

loading hay for several days and having caught cold on the third day of this particular work. He had no chill but commenced to cough quite severely. He did not stop work but complained bitterly of profuse perspiration, although it was in midwinter. At the time of my first seeing him his temperature was 99.6 degrees; pulse 80; cough very severe, and with much purulent expectoration. His underclothing was fairly soaked with perspiration. Physical examination, aside from the moist bubbling râles over the larger bronchial tubes typical of bronchitis, was negative. Under suitable treatment he made a good recovery and in four weeks was entirely well. He informed me and I was able to verify the fact that two other men working with him in loading hay were taken sick just as he was, and at the same time. I am inclined to believe that this was a case where a grass or hay bacillus was present, and in some degree actually pathogenic.

It can readily be seen how easily these allied organisms might be mistaken for potent tubercle bacilli, under certain conditions, and it is extremely probable that this very thing has been done many times in the past. Then again, may it not be possible for these closely similar bacilli, but more particularly for this so-called grass bacillus, to acquire the identical pathogenic properties of real tubercle bacilli by continued passage through cattle or susceptible human beings just as it has been demonstrated that the virulence of weakly potent tubercle bacilli is increased in intensity by passing through a series of highly susceptible animals like the guinea pig?

Now the question arises, from all the varied mass of evidence resulting from investigation of the tubercle bacillus and its allied forms, what deduction can be drawn?

Just this: From clinical and laboratory study there are substantial grounds for the belief that the tubercle bacillus is evolutionary in character, which evolution is evidenced by certain variations and gradations in a morphology and virulence modified by the chemic or biochemic conditions of different environments.

This brings us to a consideration of the soil or those conditions within the human body which favor development of tubercle bacilli and their characteristic lesions. From Hippocrates down medical men have recognized a predisposition to tuberculosis in certain individuals. In the main this predisposition has been considered a lowering of vital resistance, a weakness of the defensive forces opposed to the attack of bacterial hordes. This so-called vital resistance is an unknown quantity, and the real nature of immunity and susceptibility is at best only conjectural. Until the solution of these mysteries is wrested from the

fastness of the human body the cure of tuberculosis will remain just as chimerical as it has always been. Back to the ultimate cell we must go and carefully study those phenomena, chemic or histologic, which either arrest or permit the march of the bacterial executioner, if we would find the truths we seek.

A careful study of the lymphatic system of the human body points to the fact that this portion of the animal organism has an important bearing on the development of tuberculosis. As early as 1695 Silvius recognized a weakness of the lymphatic vessels in scrofulous conditions, and later observers confirmed his views. More recently Fox attributed a disposition to tuberculosis to certain anatomic and physiologic defects of the lymphatics, while Virchow has laid the cause of scrofula to a weakness or imperfection in the arrangement of individual lymphatic systems.

Histologic investigation teaches us that the lymph "glands" or more properly the lymph nodes act as filters of all foreign material that gains entrance to the body. Whether this property of attracting and storing up, as it were, foreign microscopic bodies is a phase of chemotaxis or simply a mechanical phenomenon, no one can say, but the fact remains.

Experiments on animals and numerous clinical facts prove conclusively that the first brunt of an invading infection is borne by the lymphatic tissue. And still further clinical observation, susbtantiated by post mortem examinations, demonstrates that the lymphatics successfully overcome and resist tuberculous infection in a fair proportion of cases.

Considerable discussion has arisen in regard to the exact nature of the protective forces resident in the lymphatic tissue. Defensive proteid substances called alexins have been shown to normally exist in the blood, their presence conferring certain forms of immunity. It is probable, therefore, that like substances are present, or produced when needed, in the cells of the lymph nodes. It may be a fact of direct importance furthermore, that physiologically the lymphatic system has an important influence on the chemic phenomena which we are pleased to call the process of nutrition or tissue metabolism.

It should be remembered that every cell of the body is having its own struggle for existence, a struggle which consists of assimilating nutritive material, of transforming the same into complex tissue elements necessary for a maintenance of cell identity and the production of cell energy, and of getting rid of superfluous end-products unnecessary for these functions. Any time during the life of a cell

or an aggregation of cells the metabolic equilibrium may be destroyed from several causes:—by variation in the supply or quality of the nutritive pabula, by mechanical injury, or by toxic influence. The result is a cell metamorphosis or cyto-degeneration, and through resulting inability of the cell to throw off chemic substances inimical to the preservation of its original identity and existence, the degeneration continues and finally ends in necrobiosis.

Now it may be properly asked what relation does cyto-degeneration bear to the development of tuberculosis? A rational deduction is just this: If substances analogous to the alexins of the blood, or other factors in the lymphatic system whose function is to arrest or destroy the influence of tubercle bacilli, are insufficient for this purpose, then the germs gain entrance to the circulation in a potent form and are scattered throughout the body. Should cyto-degenerative changes be general and extensive the tubercle bacilli will find many locations presenting favorable conditions for their growth and destructive influence. A disease, therefore, of which acute miliary tuberculosis presents a typical picture, is the result.

But if the cyto-degenerative areas are few and small, no matter how many bacilli gain entrance to the system, the conditions will be unfavorable for the development and destructive influence of all but a small number, and the tuberculous process will be limited, just as it is seen to be in the insignificant tuberculous nodules found in many lungs on post mortem examinations.

It should not be understood that all physical weakness or degeneration induces tuberculosis. Conditions of marked vitiation or depravity of the bodily structures may exist quite generally throughout the body and yet tuberculosis never occur, even when external conditions are extremely favorable to infection. If this was not so, nearly every injury or disintegration of tissue would become tuberculous at the point of solution. But we know from clinical investigation and experiments on animals that the point where tuberculous infection enters the organism rarely shows progressive tuberculous lesions. The typical tuberculous process usually becomes evident in some organ more or less remote from the atrium of infection.

The more frequent occurrence of tuberculosis of the lung would seem to militate against the theory that cellular degeneration does not induce tuberculous disease, for it has been pretty thoroughly demonstrated that tubercle bacilli enter the body more frequently by inhalation than otherwise. But under normal conditions the anatomic arrangement of the air pasages, their irregularities, and the moisture

of the lining membranes thoroughly arrests foreign particles and clarifies the inspired air before it reaches the air vesicles. Furthermore, foreign material which does reach the bronchial tubes is rapidly carried to the nearest lymph tissue, the bronchial "glands," and there left, as is shown by the post mortem appearance of the bronchial "glands" of those whose work requires the constant inhalation of air laden with soot or coal dust.

There is also ample proof that tubercle bacilli do infect the bronchial and other lymph nodes without extension to the lung tissue, but there is nothing to show that tuberculous lesions of the lung are not preceded by glandular infection. It is not strange that the lungs should most frequently present definite tuberculous lesions. When the other factors that prevent the systemic ingress of active tubercle bacilli are removed, the nature of the respiratory process, the extreme and constant tax that is placed on the cellular structure of the lung by atmospheric variation, and the trophic and circulatory changes it is subjected to by internal conditions, make cyto-degeneration of the lung more common than of any other part of the body.

In conclusion let me emphasize this fact: The development of tuberculosis in the individual is the result of a coincidence of not one but of several conditions. Those conditions are, first: A potent tuberculous infection depending for its potency on a certain degree of virulence. Second: A certain negative chemic or histologic condition of the lymph nodes, resulting from hereditary tendencies or from circumstances of environment, which fails to arrest or inhibit the growth and systemic ingress of potent tubercle bacilli. And third: A retrograde metamorphosis of structural cells in some part of the body, (more particularly in the lung), from trophic, traumatic or toxic influence which favors the local growth of the invading germ.

It can be readily understood that the first two conditions are relative, that is a particularly large amount or a specially virulent tuberculous infection might overcome resistant conditions of the lymphatic system that ordinarily would be effective against a less virulent or smaller amount of infective material. And conversely a weakened lymphatic system might prove vulnerable to what under ordinary conditions would be non-potent tuberculous material. In other words the success of tubercle bacilli in making a systemic ingress depends upon bacterial power, toxic or vegetative, which is numerically or through special potency greater than the forces, chemic or histologic, of the lymph nodes which tend to resist or prevent such ingress.

In leaving my subject I realize that there is much in the fore-

going which may be open to question and difficult of proof. But as contradiction or affirmation of any statement requires new facts or more accurate presentation of old ones, my humble deductions may prove of some slight value after all.

THE TREATMENT OF TUBERCULOSIS AT HOME.*

BY CHARLES F. MCGAHAN, M. D., AIKEN, S. C.

Mr. President and Gentlemen:

I have the pleasure of bringing before you today the consideration of a topic that is agitating the whole civilized world. Only six weeks ago a congress was held in London on this one disease. It was as largely attended by physicians from all parts of the globe as are the international congresses on general medicine. So important was the subject considered and so anxious was our profession for the report of its deliberations, that our most progressive journals arranged to receive the great Koch article by cable, and it was published on this side of the Atlantic the same week it was delivered in London.

We all agree that better results are attained by the treatment of patients in sanatoria, and at resorts where there are provisions made for out door amusements, but it is only the minority and lucky few who are fortunate enough to be able to avail themselves of these means. The overwhelming majority must be treated at home. I do not mean in the country a few miles from where these patients have dwelt, but in their actual homes. As it will be many years before the state governments, backed by the philanthropic public, will have adequate accommodations in the different sanatoria for these unfortunates, the first point for us to consider is the care we can give them without such advantages.

OPEN AIR TREATMENT.

Fresh air being of the greatest importance, we should consider the location and ventilation of the apartment, but if there is a balcony to the house we had better place the patient's bed upon it and have a suitable awning made for shelter; if the house should be a tenement without a balcony the best thing to do is to fix up the roof so that we can there place a bed and thus locate our patient out of doors. Should the house be situated in one of our smaller towns, with a small yard or grounds around it, we can build what the Germans call a "Lie-

*Read before the 27th Annual Meeting of the Mississippi Valley Medical Association.

genhalle" for the patient to stay in, or we can put him in a tent. The "Liegenhalle" is to be preferred because one side is entirely open, revolves upon cog wheels, and can be turned to keep out the rain and strong winds, while the patient is protected and remains practically out of doors. In selecting a tent I prefer a circular one with a large opening in the top which will allow the foul air to escape, the fresh air entering at the bottom. Should it be more convenient for us to get the square or army tent, it will be necessary to have a large flap made in the rear part of the tent, two feet wide by two feet six inches long, directly opposite the entrance, which, by leaving the flaps at the entrance and the ventilator open, will secure an excellent current of air. I prefer the tent placed upon a platform about two feet from the ground, so as to allow a circulation of air under it. The patient must be kept warm by proper clothing and in very cold weather, if necessary, hot water bottles can be put into the bed. There should be no carpet upon the floor, nor draperies in the apartments occupied by phthisical patients. The furnishings may be as comfortable as the purse can afford and as luxurious as hygiene will permit.

CARE OF MEMBERS OF FAMILY AND FRIENDS OF PATIENT.

It is in protecting the other members of the family from the disease that the general practitioner has the opportunity of doing the most good. He must recognize the disease early, and now that most of our states have founded bacteriological laboratories for free examination of sputa, it is the duty of the practitioner to send the sputum, in every case in which there is the least shadow of suspicion, to one of the laboratories for a report. Upon tubercle bacilli being found, it seems almost useless for me to say that the patient must be provided with a bed in which he can sleep alone and, if possible, he should be the sole occupant of the room, not only for his own benefit, but also for the protection of the other members of the family. If my attention had not been called to this point a short time ago, when I saw two young girls occupying the same room and bed, one being in the last stage of phthisis, the other seemingly well, it would be superfluous at this period of our knowledge of the etiology of the disease to touch upon this subject.

The habit of kissing which is so often resorted to by members of the family and the invalid is also dangerous and should be prohibited.

CARE OF SPUTA, HANDKERCHIEFS AND CLOTHES OF PATIENT.

It is well for the patient to have an antiseptic solution with which to rinse out his mouth several times a day. Not that I expect to thus kill the bacilli, but because therewith any bacilli may be removed that

may have lodged against the teeth or the sides of the mouth. The greatest attention should be paid to the care of the sputa which should be received in one of the sputa-cups, of which there are a great variety on the market. I prefer the paper cups that can be burned, to the pocket sputa-flasks which have to be sterilized each day after use. The pocket sputa-flasks may be very good for patients in sanatoria, as they are there taken charge of and thoroughly sterilized by competent persons, but with patients at home, I generally find that they will not, and often cannot sterilize them; so I much prefer their using the paper cuspidors instead. When taking exercise away from home, such as walking or driving, I advise expectorating into cheese cloth which, after use, is put into an oil-silk bag; the latter on returning home and after its contents are burned, should be thoroughly wiped out with an antiseptic solution. I prefer the use of cheese cloth to a handkerchief because, being cheap, it can be burned. Of course in institutions all linen can be thoroughly sterilized before it is washed, but at private homes my experience is that the difficulties of doing this thoroughly are so great that patients and their families become careless; therefore, I think it best to destroy by fire everything possible that comes in contact with the patient's expectoration.

VENTILATION OF APARTMENTS.

Under "Open Air Treatment" I laid particular stress upon the ventilation of the apartments in which the patient lives, and I wish now to call your attention to only an additional point or two: Do not be afraid of the night air. Insist upon having the room as thoroughly ventilated by night as in the day; and in winter, by all means have an open fire. With a stove it is almost impossible to control the heat.

Several years ago, in the White Mountains, I had under my care during the summer a poor girl suffering from phthisis. Some philanthropic people raised a sum of money to send her south. The amount was not sufficient to procure other than poor accommodations, and as her home was a New England farm-house, with every room heated by stoves, I advised her to use the money in building for herself a good airy room with a large wood-fire-place. She did so, and I was much pleased, upon my return the next summer, to find that she had greatly improved. She continued to gain and has been well now for some six years.

NOURISHMENT.

Equally as important as ventilation, is the proper feeding of the patient. Some years ago, when frequent feeding was considered most important it was the custom to give food every few hours, while a few

years later it was thought best to give the patient only three meals a day, and nothing between times. My own experience has been that we cannot follow any set rule and that each case must be studied separately. What we should aim at, is, to give our patients as much nourishment as they can assimilate. I think it is well to give some hot drink, on awakening in the morning before the patient gets out of bed, such as a glass of hot milk, cocoa or beef tea. I prefer a glass of milk and vichy; it is, however, not of enough importance, but that we can leave the choice to the palate of the patient. There are two advantages to be gained by the patient's taking warm nourishment upon awakening. First, it loosens the mucus and enables it to be raised more easily; second, it strengthens the patient, so that he experiences less fatigue from dressing. If the patient's digestion permits, it is wise to give him three meals a day and also some light food between the meals and upon going to bed. But if there is the slightest sign of distress of the stomach we must take care of and rest the digestive organs, adapting the quantity and quality of food to their present capacity. In regard to the kinds of food I much prefer those that are prepared fresh in one's own kitchen, to manufactured ones, although as to the latter I do not wish to be misunderstood, as I appreciate fully the value of many of the laboratory products with which you are all undoubtedly familiar; and I have seen a great deal of good accomplished by them. I am, however, partial to milk in its natural condition or, if necessary, with lime, barley or vichy water. I try to have a patient take from a quart and a half to two quarts a day. I consider eggs next in importance to milk and advise my patients to take at least four a day; it is immaterial whether they take them boiled, poached, or in sherry, but I do not approve of them fried nor do I allow any fried food. Roast beef, beef steak, mutton, lamb, turkey or chicken, with vegetables should be given with enough variety to tempt the appetite. Plain pudding or fruit may be allowed for dessert, but the eating of pastry should be discouraged. I do not agree with the German physicians who advocate the use of wine or beer with the midday or evening meal. On the contrary, I consider that the patient is better without them, and I allow whiskey only when from some cause, the patient becomes exceptionally fatigued, or needs a stimulant. I do not think its regular use is productive of good results.

REST AND EXERCISE.

I now come to the last one of the trinity—air, nourishment and rest. We have already considered the first two, and I deem rest of equal importance with them. While there is fever it is necessary to

keep the patient in a reclining position. For this purpose I find the wicker reclining or steamer chair most comfortable. But should the patient not be able to afford this luxury, a couple of armchairs will answer the purpose very well—one to sit in, and the other tilted to hold the feet. After the fever ceases, exercise should be encouraged, particularly such as will expand the chest. The breathing tube which admits of pulmonary gymnastics is then of especial value. I find, however, that most patients are apt to overdo, hence we must prescribe not only the kind of exercise but just how much should be taken, as a great deal of harm comes from over fatigue. We should always warn patients to guard against getting tired; walking is the safest mode, but horseback riding, golf, and bicycling are all good forms of exercise but only for selected cases, and then in moderation.

MEDICATION.

We have no specific drugs for this disease. If one has followed the literature of the past twenty years, and has seen the numerous drugs and methods of treatment that have been advocated by excellent minds, and endorsed and lauded by the leading men of the time in the profession only to be abandoned for new ones it will convince any one that the routine use of drugs is of little value. Tonics and medicines that build up the general system have their uses, and as symptoms present themselves of sufficient importance for treatment, we are called upon to prescribe. Of the numerous tonics I have had most excellent results from iron, strychnine and arsenic. I consider malt and cod liver oil as foods, and have found few patients who could not take the combination when mixed in suitable proportions. Dyspepsia should be treated by controlling the diet, and, if needed, by the use of drugs. The different forms of dyspepsia which occur in phthisical patients are so varied that it would be impossible, in an article of this size, to do more than say that each form must be treated according to the symptoms presented.

Cough needs no treatment unless it is so bad as to disturb the rest of the patient at night. In such cases we are obliged to use one of the preparations of opium, and it devolves upon us to select the one which is least apt to disturb the patient's stomach. Codein and heroin have, in my hands, served the best purposes. All cough mixtures are an abomination and only disorder the digestion. When the general health improves and the lungs heal the cough will cease, and not till then.

WHEN CAN WE CONSIDER A PATIENT CURED?

It is very important that we recognize a condition when the

patient is to all intents and purposes cured and able to mingle with his fellow men, without danger of infecting them. When the patient has had no fever for six months and his cough has ceased and when, upon repeated bacteriological examinations, we fail to find tubercle bacilli, I think we can safely consider the patient cured. In this connection it is also important that we should educate the public so that it may know when there is no danger of contagion from contact with recovered patients.

The following case which came under my care will illustrate this point: A patient who had been under treatment for six months had improved so much that he had gained twenty pounds in weight. He had been without fever, cough or expectoration for two months and the chest had quite cleared up. What little expectoration could be secured I examined repeatedly for tubercle bacilli, and failed to find them. He returned north, and was pronounced cured by his physician who is one of the best known specialists in the East. In spite of all this his employer would not allow him to return, but preferred to pay his board at a summer resort, rather than to have him around his stable.

THE AFTER CARE OF A PATIENT WHO HAS ONCE HAD TUBERCULOSIS.

It is necessary that he should always live in good airy apartments, and have plenty of fresh air, both day and night. He should endeavor to obtain an occupation that will keep him out of doors. His nutrition should always be kept up to a high point, for he has demonstrated by his first attack, that he has the suitable soil which is liable to reinfection. He therefore finds that whenever he allows his general health to become impaired the greatest strain is placed upon the weakest part, and this part will first give way; hence, it is imperative that a patient once having had pulmonary phthisis should always take care of himself and should be very watchful for any sign of failing health.

Dr. Beverly Robinson, in the St. Louis Courier-Journal, has sounded the key note of the after care of pulmonary patients, when he says, "Legislation should make it imperative that the tenements, workshops and apartments of the poor should be so constructed that the occupants will get plenty of sunshine and fresh air." Take a consumptive, who has been cured, and send him back to live and work in a dark and ill ventilated apartment, and he will soon fall victim a second time to the white plague.

WHAT SHOULD BE THE ATTITUDE OF THE MEDICAL PROFESSION TOWARD THE PUBLIC AND THE INDIVIDUAL SUFFERING FROM TUBERCULOSIS.*

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The discovery of the tubercle bacillus by Koch in 1882 caused renewed interest in the investigation and discussion of tuberculosis. The discovery of the cause led to the hope and belief that ultimately a cure for the disease would be found, as well as a more accurate knowledge of the means by which it is spread. Knowing how it is disseminated, its prevention would follow as a natural sequence when every avenue was safely guarded.

This is not only a medical subject of great significance, but an economic one as well, involving as it does a great saving of life and therefore of increased productive force to the State and individual. It becomes, then, one of vital importance because of its wide range of application. Much has already been learned that will be of practical and lasting benefit. On the contrary, many opinions and beliefs that are now held and freely expressed, will, doubtless, as time goes by prove to be erroneous and as a consequence be greatly modified or entirely cast aside. Almost from the earliest history of medicine there have been those who held to the opinion that in some way, and under certain conditions, tuberculosis was communicable. Few, I take it, will dispute that fact today. But the manner in which it is spread is not so plain. The sputum during the late period of the disease contains the bacilli in large numbers. The breath does not contain the germs and is, therefore, devoid of danger. The disease is not communicable from person to person after the manner of diptheria, scarlet-fever, and small-pox, but the bacilli in some way, find ingress to the body where in a suitable soil they grow and multiply. A vulnerable constitution brought about from any cause whatever, environment, and hereditary predisposition are important factors.

I am inclined to think that "hereditary predisposition" is a factor of more potency than we are willing to admit. In the August 24th

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number of the Medical Record, an editorial, based upon an address by Dr. Edmund R. Wilson to the graduates of the Yale Medical School, on "The Higher Claims of Minute Research in Biology and Medicine," gives an abstract which, to my mind, is significant. In speaking of the phenomena of cell division, Dr. Wilson, says: "The fertilized egg receives the neuclear matter in exactly equal quantity from both the parents, in the form of rod-like bodies known as chromosomes, that are identical in number, form and size in both male and female. Our researches on cell-division are converging with ever increasing probability to the conclusion that the paternal and maternal materials contained in the chromosomes are, or at least may be, equally distributed by division to all the cells of the body whatever be their structures or functions. In other words, every cell may thus receive neuclear material from both parents and thus bear within itself the germs of the hereditary predisposition of both."

By a majority possibly, of those competent to speak with authority, it is believed that the disease per se is so seldom inherited as to play a minor rôle in its continuance. It must be admitted, however, that in a surprisingly large proportion of cases, 50 per cent. according to some statistics, a history of the disease can be found in the forebears or some one or more of the immediate family. The spread of the malady in these families is explained by domiciliary contact and the inhalation of the germs. In a great many of these instances this will not hold good, because it is constantly cropping out in those widely separated and who had not seen each other in years.

We frequently speak of the inheritance of insanity, syphilis and diseases of a kindred character and why not of tuberculosis? Of the possibility of such inheritance there is no doubt; its frequency is the only point in dispute.

The present commonly accepted theory is that the sputum is the main source of contagion; being spit upon the ground, becoming dry, the bacilli are carried by currents of air and inhaled by the predisposed individual, and thus the disease is inaugurated. That this is dangerous to the public no one will deny; that every possible means at the command of the commonwealth and municipality should be employed to put an end to expectorating on the sidewalks and in public places and conveyances, all will admit; that a wider range of distribution is thus constantly maintained and the danger to the susceptible person accentuated, is conceded; but is it proven that this is the principal source of danger as is so stoutly insisted upon by a majority, possibly, of those who write upon the subject? And are we not in danger of pro-

ducing a needless feeling of alarm, and in many cases actual hardship, among people by insisting too strongly upon the great peril attached to it? I am aware that the lungs being the primary seat of the lesion, is considered proof of inhalation of the poison: if this is true, the larynx and tonsillar tissues ought to be the initial seat more frequently than they are, when as a matter of fact primary tuberculosis of the larynx is a very rare thing. Objections may be had to this on the ground that lodgement of the bacilli in the tonsils and pharynx is difficult because of the well nigh constant motion in swallowing. This is no greater for children than adults. Moreover the tonsils are considered the atrium for the germs of other diseases that occur very frequently, viz.: rheumatism and La Grippe. It is well known that sunlight will destroy germs with marvellous rapidity—some of course sooner than others. It has been shown that the diffused solar rays entirely destroy the virulence of tubercle bacilli in from five to seven days and that the direct rays will do so sometimes in a few minutes, or at most in a few hours. Ransom has shown by experiment upon the lower animals that the germs are innocuous in from two to fourteen days after exposure to light, but by exposure in the dark only, they retained to some degree their infectiveness for a much longer period. They are less infective when exposed to currents of air than when they are not. "Light and currents of air destroy them quickly." These experiments were often repeated and each time gave the same result. Even when the bacilli are injected into the most susceptible of all animals—the guinea-pig—for purposes of experiment the slightest deviation of temperature, either of the culture media or atmosphere, renders the result negative. Sudden atmospheric changes lessen in a great degree the vitality of the germ. In this zone the regular changes of the seasons, to say nothing of the sudden and numerous barometric oscillations inhibit in a large measure their power to produce the disease. May not the non-pathogenic germs in the air weaken, or in many instances entirely destroy the virulence of the pathogenic ones?

Dennison in an article in a recent issue of the New York Medical Journal says the destructive influence of sunlight upon the tubercle bacillus is now generally conceded.

Moreover, when the individual is so far advanced with the disease that the sputum contains the bacilli in large numbers we have mixed infection. The various cocci are present in innumerable quantity, grow rapidly, and by their saphrophitic action cause almost immediate decomposition—analytical processes—of the sputum, thus rendering it an unsuitable medium for the tuberculous germs. To

have the bacilli resistant, they must be raised on suitable media and at proper temperature, and sudden freezing and thawing will inhibit their growth and render them in a measure non-virulent. These germs having weight are found in greatest numbers near the ground; consequently children would be more liable to become infected than grown persons. There is neither histologic nor physiologic difference between the mucous and adenoid tissue of children and adults, unless it should be in the fact that in the latter the glandular tissue is more active and the lymph spaces larger. In this event the germs ought the more quickly to be taken up and find lodgment, and thus produce changes in the young, very quickly and easily discernible in a body so impressionable, and not lie dormant, as it is claimed, until late in life.

However, it is not impossible for the germs to remain inactive in the gland tissue of children and at some favorable time in after life the disease make its appearance as a consequence of an early infection rather than of a late one. Steffen has recently published the results of 260 autopsies on children in which he finds that more than 25 per cent. of them died of tuberculosis.

Children are much more vulnerable to all forms of disease, hence if the dust-laden air is so dangerous, more children ought to take the disease than those of mature years. This we are told is not true, because the greater number of deaths occur between the ages of 17 and 35. Again we would logically conclude that in those health resorts that have for years been visited by consumptives the increase in the number of tuberculous individuals among the permanent resident population would be very marked, because they have been allowed to expectorate hither and yon as pleased their own sweet will. In a letter received some years ago from Dr. Karl von Ruck of Asheville, N. C., (and I am sure no one will question Dr. von Ruck's qualifications to speak upon a question of so much importance) concerning this point, he says: "There is no apparent increase of tuberculous disease in the permanent resident population of this resort; on the contrary, tuberculosis is practically unknown amongst those who have resided here for several generations, and those who did not resort to this locality on account of already present tuberculosis." The same can be said of other resorts of a similar character both cis and trans Atlantic. In the oft quoted Brompton Hospital for Consumptives in England, there is not a well authenticated case of an individual contracting the disease within its walls; if so it has escaped my attention. The same may be said of Falkenstein, Germany.

Gardiner of Colorado Springs, an acute observer, has studied the

subject very carefully and finds that the number of cases originating in the city is very small and that, too, in spite of the fact that the "Springs" have been the resort of consumptives for twenty years. Fluegge denies that the bacillus-laden dust is the dangerous factor in infection. He has only been able to produce the disease when some lesion of the respiratory tract existed. It is his opinion that the danger of infection by the dry sputum is improbable.

Do not misinterpret my meaning and assume that I think there is *no* danger from the dried sputum; far from it. However, there is, to my mind, an exaggerated feeling of alarm in certain quarters caused by intemperate statements from the profession and much inconvenience and in many cases actual and needless suffering is occasioned. As an illustration I need but point out to you the action of some of our western states in passing laws prohibiting consumptives from coming within their borders, hotels and boarding houses refusing them even temporary shelter. For this inflamed popular sentiment the profession is to blame.

A few years ago Dr. Baker, Secretary of the Michigan State Board of Health, issued a circular in which he stated that three thousand cases of tuberculosis occurred annually in that state from contagion alone. By what process of reasoning this distinguished physician arrives at such a conclusion I am unable to tell. But why this number? If three thousand, there must have been a time when there were less, and a priori there would be a time when there would be infinitely more, being incremental in character. If this unfortunate state of affairs were true, Michigan would be ere this, the land of the "great white plague" instead of the splendid commonwealth that it is; and what would be true of that state would be true of all others.

The greatest source of danger from the expectoration of tuberculous individuals comes from the overcrowded tenement districts of our larger cities, where sunlight and currents of air are well nigh unknown. Here the environment for the continuance of the disease is ideal. The habits of the people are vicious in the extreme. Their constitutions, undermined by excesses of all kinds, particularly alcoholic, with lack of good, nutritious food, as well as raiment, and pure air, make them easy victims of this dread malady. Being ignorant of the danger arising from the sputum, its destruction is not thought of; indeed not considered necessary and absolutely no care is taken. Moreover, from conditions beyond their control the sick and the well must occupy the same sleeping room, often the same bed. This it is conceded by all is exceedingly dangerous under the most favorable circumstances and

should not be done, but in the tenement districts and among the very poor elsewhere the danger is infinitely increased. These, coupled with repeated intermarriages give a gloomy outlook for this people unless the most rigid sanitary measures are carried out. This as is well known is being done in some cities, but by no means in all to the extent it should be. It is here our best energies should be put forth, and well directed efforts continued. If the State could provide homes for these unfortunate poor, in some healthful locality, far removed from the great centers of population, it would confer a lasting benefit upon the public and the individual, by limiting the spread of the disease and curing a certain per cent. of cases, thus restoring them to family and friends and making them a productive force to the State. In cases of this kind "we are our brother's keeper." He is human like ourselves and is entitled not only to our sympathy but to our protection. It is his misfortune, certainly not always his fault if he is so sorely afflicted. That tuberculosis in its incipiency is curable can no longer be doubted. Unfortunately many of these cases are not seen until the disease has made such inroads as to make it well nigh impossible to do anything; or if seen early a proper diagnosis is not made.

In Koch's now much discussed paper, read before the Congress of Tuberculosis in London, he denies the identity of human and bovine tuberculosis and doubts the transmissibility of the latter to man, thus discrediting the necessity of the precautions that have been taken in the destruction of tuberculous cattle. This is no new theory and certainly is not original with Koch. In August, 1899, Professor Adami read a paper before the Canadian Medical Association in which he calls attention to the lack of evidence to prove the hypothesis of the transmission of animal tuberclosis to man. He says that when human tubercle bacilli are injected into animals the tendency is to become localized and lead to transient effects. In the same year Dr. Theobald Smith of Massachusetts said, "I have found in a set of tubercle bacilli, that is, isolated human sputum, and in the disease in cattle that there were certain differences that could be easily recognized by laboratory methods," and that thus far in his work he had not found human and bovine tubercle bacilli to be identical. He adds, however, that the strength of his position depends largely upon the number of cases examined, and unless my memory is much at fault he took a similar position the year before, that is in 1898, in a paper read before the Association of American Physicians in Washington City. Others have written along similar lines. As to the bacilli in the milk of tuberculous cows, it is pretty generally agreed that in those having well marked tuberculosis, the

milk is very apt to contain the bacilli and should not be used unless sterilized. The per cent. of frequence varies with the observer. Thus Obermüller found the germs in 61 per cent. of the samples of milk sold in Berlin, while Petri found them in only 14 per cent. Intestinal tuberculosis in children has been offered as proof, not only of the milk origin of the disease, but as well of the identity of human and bovine tuberculosis. Primary intestinal tuberculosis is a very rare thing; indeed, its existence is denied by clinicians of wide experience. Still, of London, says the commonest channel of infection of tuberculosis in children is through the lungs; when the mesenteric glands are involved it is the intestines; the latter is less common in infancy than in later childhood. From this he argues that milk is *not* the usual source of the disease in infancy. From the foregoing it is very evident that until it is definitely determined that bovine tuberculosis is not transmissible to man, that neither the meat nor milk of a tuberculous animal should be used in an uncooked state, and that in well marked cases the cow should be killed, and paid for out of the public treasury. It is an unjust hardship to expect the unfortunate owner of a tuberculous cow, not to be recompensed for the destroyed animal, even though the destruction be for the public good. The interests of the State and individual are identical; they should be reciprocal.

No teacher should be allowed in the public schools who is suffering from tuberculosis. During the constant, and many times well nigh immediate contact with the pupil the act of coughing projects to a considerable distance innumerable bacilli, which being inhaled by the susceptible child, either as a result of inherited predisposition or lowered vital resistance from any cause, may easily induce the disease. To say that ventilation in our public schools is sadly deficient, is expressing it mildly. The atmosphere is rebreathed and breathed again until each child suffers from a semi auto-intoxication. If to an atmosphere of this kind you add the germs of a disease of this character, and the child in the condition I have indicated, it needs no philosopher to tell what the result will be. The parents and children have a right to demand that every safeguard be thrown around the latter while pursuing their studies. Larger and more numerous playgrounds should be provided and more time allowed for recreation. Simple devices for muscular development should be supplied and the necessity for their use should be pointed out to the children; more especially to those with a hereditary predisposition. Particularly is this true in the densely populated portions of our larger cities.

What then should be the attitude of the profession toward the public and the individual suffering from tuberculosis?

In the political parlance of the day it should be a campaign of education. The profession having a thorough and comprehensive knowledge of the different sources of danger, the public and the individual should be told of them, and the best means of avoiding them. As I have said before, the interests of all being identical, they should be reciprocal; the physician pointing out the way, the individual, singly and collectively, contributing to "the end in view" by complying with the rules laid down by the profession. "Pro bono publico" should be the motto.

Whether this would mean the compulsory notification of all cases of pulmonary tuberculosis is a debatable question; or rather I should say what action should be taken after notification had been given? Not belonging to the same class of diseases as scarlet fever and diphtheria, the placarding of houses and apartments, with isolation of the individual would be useless, and no doubt would meet with the most determined resistance. If, simply to furnish information as to the destruction of sputum, and hygienic matters generally, it would occasion no offence and would, no doubt, be received with greatest kindness. All this, however, could be done by the conscientious family doctor without notification.

The State and municipality should enact such laws as will make it an offense punishable with a fine for an individual suffering with well marked tuberculosis of the lungs to spit upon the sidewalk or any place where the people congregate. It should be the duty of the police to see that these laws were enforced. Every consumptive when away from home should provide him or herself with Japanese napkins or bits of cheese-cloth—both inexpensive—in which the sputum can be collected (and that, too, without any offense to the most fastidious) and then burned. Paper spit-boxes are an unpleasant sight and should be reserved for the home, where they can be used. The room or apartments in which a consumptive has lived for any considerable length of time should have all belongings removed, renovated and subjected to sunlight and currents of air, and the paper removed from the walls and burned and the walls thoroughly cleansed before new paper is put on in its stead. The floor should be thoroughly scrubbed with hot water. All windows should be removed. The most rigid supervision of the dairy and all dairy products should be made by one competent for the work and not because of his ability as a ward-caucus manipulator, and until it shall be determined by innumerable experi-

ments carried through series of years that bovine tuberculosis is not communicable from animals to man, if a tuberculous cow is found she should be taken from the herd and the milk not allowed for domestic purposes, and this, too, even though the udder show no tuberculous lesions. If decidedly tuberculous, the animal should be killed and the carcass destroyed by fire. No butter should be made from a diseased animal, no matter how slight the lesion. The importance of this precaution is apparent from some experiments made by the Imperial Health Office at Berlin, where 250 guinea-pigs were inoculated by peritoneal injections with "butter bacilli," cultivated from butter made from the milk of tuberculous cows, with positive results in all of them. The public press can aid the profession greatly by printing articles from time to time from a reliable source, pointing out the necessity for more rigid sanitary laws (including the complete destruction of the sputum of the consumptive) and the great benefit to be derived from a strict compliance with them.

In our large cities public baths should be instituted where the deserving poor can free of charge take a bath at least twice a week. There is nothing that will so fortify and strengthen the debilitated as a cool or cold plunge. However desirable this may be as a health-giving measure, it will be a long time until it will be done. Meanwhile let the profession urge upon the people in the tenement house districts, and upon all who do not practice it, the benefits to be derived from frequent bathing. An elaborate outfit is not necessary; a bucket with two gallons of clean water in it, and a sponge or towel is all that is essential, unless you care to add to this some good soap. Bathing not only strengthens nerve and muscle but aids in nutrition and the public must be made to comprehend the fact that *nutrition* is the fortress against bacterial invasion; that the individual *weakened from any cause* is more liable to take the disease than one who is not; that the *debilitated individual* offers the *least resistance,* hence the best soil for the germ to grow easily and rapidly.

TUBERCULOSIS AND CHILDHOOD—A RESUME.*

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That tuberculosis is a communicable disease, that its morbid processes are caused by the bacillus tuberculosis, that its lesions are distributed generally or limited locally, and that these morbid processes produce characteristic effects, each student of pathology and bacteriology knows.

However, in children, the early recognition of this disease, its peculiar manifestations, its relations to other affections, the preventive measures for its control, are of vast importance to each of us; for the "Child is father of the man;" and whatever knowledge is disseminated for the good of the child will certainly make the man stronger, and better able to cope with the struggles of existence.

The human cells are the defenders against the incoming agents of destruction. Heredity is our inheritance of these cells; if these cells are sufficiently powerful, that is, if our heredity is excellent, we shall conquer these enemies; if not, they will overpower us. In infancy and childhood, cellular activity is very much pronounced, for there is a constant rapid growth and development, and when it is necessary to combat disease, a still further exertion will be required of the cells, and the task to be overcome will be proportionate to the relative hereditary strength. In spite of this hereditary strength, when previous exertions have too far lowered the vitality of the cells, disease will be victorious; and on the contrary when deficiency of hereditary strength is early recognized, by fortifying cellular resistance, and avoiding cellular irritability, disease can be prevented.

How then, does this want of cellular resistance, of vital energy, of immunity, or of hereditary power manifest itself as tuberculosis, so that the disease can be early recognized? Although, today, we have at our command more precise scientific methods and instruments, and the aid of bacteriology, we must mainly rely upon clinical diagnosis of this disease in children. The sputum of children is often not expectorated, and commonly swallowed, and the absence of bacilli in the tuberculous, inflammatory products is not rare. The injection of tuberculin, as a means of diagnosis in children is not devoid of the danger of the further spread of the disease.

*Read before the American Congress of Tuberculosis; May 16th, 1901.

Remembering the seats selected for the development of tuberculosis, viz., the tissues of the skin, subcutaneous tissue, mucous, serous, and synovial membranes, piamater, the glands, bones, and the lungs, liver, spleen, kidneys and testes, we can associate these seats with the following diseases; scrofulous (so-called), subcutaneous, and tuberculous abscessses, glandular tuberculosis, osseous tuberculosis, synovitis, meningitis, general tuberculosis, and tuberculosis of the different organs.

As is well known, glandular enlargement occurs in other infections and we must be able to differentiate between tuberculosis and them.

That glands are infected at first, is proven by having found bacilli in glands, and not in the lungs in pulmonary tuberculosis. Glandular enlargement is commonly found in children and is the forerunner of more serious future trouble, when left without treatment. The origin of the bacillary infection which ends in the miliary form, and in meningitis, has been traced to caseous tracheal and bronchial glands; if these glands become large, their presence can be recognized by dullness on percussion between the scapulae; these glands may so enlarge as to extend up in the neck along the sides of the trachea. Bearing in mind the frequency of the occurrence of such glands, and the presence of spasm, often mistaken as spasmodic asthma, or some laryngeal disease, the diagnosis can be made.

Glandular tuberculosis, often called scrofula, although occurring at any age is very common in the young. The glands become enlarged, tender and often undergo suppuration; those of the neck, of the axilla, of the groin, or of the mesenteries becoming involved. Often these glands become smaller, and undergo calcareous change; the tubercle bacilli are retained, and at some later time in life when the individual is run down, set up a general or pulmonary tuberculosis. Associated with these glandular enlargements, we often find inflammation of bones or joints, and ulcerations of skin and mucous membranes. The child is anaemic, slowly emaciating, and having a hectic fever. If we suspect lung tuberculosis associated, and examine the chest, we are often surprised at so little involvement; there may be a few crackling râles, chiefly below the nipples, and in the scapular region. In young children it is very important to examine the lower lobe of the lung, for here it is common to find a cavity, although in adults we seek it in the upper lobe. In tuberculous disease of the mesenteric glands there is wasting of the child, enlargement of the abdomen, pain, griping after ingestion of food, diarrhoea, and pyrexia.

On palpation around the umbilicus, by pressing backward toward the spine, and by carefully manipulating the abdominal wall the glands are detected; the bowels should have been previously evacuated. In longer standing cases, when the peritoneum is involved, adhesions between the intestinal coils, and between the latter and the abdominal wall take place; these coils of matted intestines can then be detected. Ulceration of the intestines and localized abscess often follow. The severity of the diarrhoea is dependent upon the extent of the ulceration of the intestine.

Where evidence of glandular tuberculosis is present and the child is wasting away, losing appetite, becoming paler, cross, fretful, its sleep being disturbed, hands held clenched, you may expect tuberculous meningitis, often described under head of acute hydrocephalus. Following these preliminary signs, the child's pulse becomes rapid and it shows it has pain in the head by putting hand on head and crying out at the slightest noise or light. Then follows projectile-like vomiting, pupils become contracted and irregular and abdomen is retracted.

These symptoms last three or four days or a week with an irregular fever of an intermittent type. Then come the stages of the disease that are marked by dilated pupils, slow pulse, cessation of crying, hemiplegia, stupor, irregular pulse and respiration, and coma.

Tuberculosis of the skin has been mentioned above, and we shall briefly dispose of it because rarely present in children. Sometimes there occurs in so-called scrofulous children ulceration of the skin at its junction with the mucous membranes, for example at the lips, and at the vulva. Recently, I have seen such a case, the diagnosis of which was properly made by laboratory examination. Frequently onychonosis is of tuberculous origin. Injuries to the skin are often followed by involvement of glands through the lymphatic circulation. Iritis tuberculosa, occurring mostly in children, is rare. The diagnosis is determined by the chronicity of the affection, the characteristic appearance of the iris and by its resistance to all ordinary treatment for iritis.

Proceeding to the mucous membranes, it is to be expected that the presence of enlarged tonsils, adenoids, nasal or other obstructions to proper respiration will cause tuberculosis. In these structures, proper soil is found for the lodgment of the bacilli as well as other pathogenic germs and the latter are thus carried through the system. Middle-ear disease is also caused by the presence of these obstructions, and in a similar manner the resulting mastoid disease is often tuberculous. The importance of removing said growths cannot be overestimated. It is wrong to wait until the child "overgrows them" for

meanwhile the chest capacity becomes less and less, giving rise to the sunken and pigeon chest, which owing to the lack of tidal air, affords proper soil for the development of pulmonary tuberculosis.

Familiar to both physician and surgeon are synovial and osseous tuberculosis. Ostitis of foot, caries of phalanges, of fingers, ribs, sternum, mastoid, and nasal bones, and dactylitis are met commonly. Chronic tuberculous abscesses, originating from lower dorsal and lumbar spine, psoas abscess, hip, knee, elbow and wrist disease are to be mentioned in this connection.

Cold abscesses, in the form of small subcutaneous abscesses are often present in infants a few months old. First, they appear as small nodules, the size of a small pea or less, situated on the limbs or trunk. They are mostly chronic in their course, either remaining stationary, slowly suppurating or becoming larger. Eventually the skin assumes a reddish purple color, becomes thinner until at last there escapes thin pus, often mixed with blood. When examined, bacilli will often be found in the discharge.

Of the organs, there is hardly one that may not be affected with tuberculosis. If the kidneys, liver, spleen, suprarenal bodies, larynx, testicles are involved, it is usually secondary to general tuberculosis or pulmonary tuberculosis. No attempt will be made to describe the affections separately of these organs, as these descriptions may be obtained elsewhere.

How to combat tuberculosis is now engaging the attention of the medical world. In introducing this subject, I stated the importance of the rôle which cellular activity plays in children. At the beginning phase of life the cell should be strengthened. The feeding of the infant and child must be properly done, in order to furnish the proper growth and development for the cell. Waste must be properly eliminated by properly dressing, by attentions to the skin, by properly bathing, and by attention to the other excretatory organs.

Regular daily bathing with cool water acts as one of the best stimulants to cellular activity.

Exercise in children is too often neglected at the expense of mental attainments. Children should sleep in well ventilated rooms. Overcrowding, such as is permitted in the greater cities in tenements, is criminal.

Philanthropists can find no better field for usefulness than building large model tenements with spacious courts, the roofs of such tenements to be turned into gardens in summer, and enclosed glass sun-

parlors in winter, for playgrounds for the children. If such were done, a large percentage of lung diseases would disappear.

Weakly infants and children would by these means greatly strengthen their cellular resistance to all germs.

In addition, proper medication and direction by the family physician, as well as the isolation of already diseased children in sanatoria and rural colonies, would terminate this dreaded affection.

ORIGINAL TRANSLATIONS.

THE TREATMENT OF TUBERCULOSIS OF THE EPIDIDYMIS AND TESTICLE BY LIGATURE AND DIVISION OF THE SPERMATIC CORD.*

BY DR. MAUCLAIRE OF PARIS.

PRELIMINARY CONSIDERATIONS AS TO PATHOGENY AND TREATMENT.

Tuberculosis of the epididymis and testicle is treated by some authorities by early castration, and by others by conservative procedures. In our opinion, all the possibilities of the lattter have not yet been exhausted. If there be such a thing as a localized tuberculosis, it is surely seen when this disease attacks the testicle.

In place of removing this organ and its chief excretory duct, the epididymis, could we not ligate either the vas deferens, the nutrient artery of the testicle, or the veins and lymphatics (for the latter vessels should contain the internal secretion of the gland); or finally could we not ligate all these various structures—in other words the totality of the spermatic cord—at the same time? These various ligatures we have either already performed, or we intend to practice them, in order to induce atrophy, not only of the testicle but of the epididymis as well, when the latter has become infected by tuberculosis.

Pathogeny:—In order to appreciate thoroughly the possibilities of this operation, it is necessary to take into consideration first the actual state of our knowledge of the pathogeny of tuberculosis of the epydidymis and testicle. According to some authorities, Reclus for example, genital tuberculosis begins in the epididymis. Other writers like Guyon and Lancereaux believe that the infection originates in the prostate and seminal vesicles, and invades the epididymis by extension from the latter structures. Finally a long series of observers look

*Translated for the Journal of Tuberculosis.

upon genital tuberculosis as a disease which begins in the kidney and descends to the peripheral organs by succession of continuity, viz.: the bladder, prostate, seminal vesicles, vas deferens, epididymis and testicle.[1] The possibility of infection through the urethra by sexual intercourse has been conceded by various authorities; but cannot be demonstrated by animal experiment.

Haematogenous infection of the genital apparatus is not a matter of doubt, because we know that Koch's bacillus exists in the blood of the tuberculous subject, albeit in very small numbers.[2] A noteworthy fact is the grafting of a tuberculous process upon epididymitis of gonorrhoeal origin. Does not this suggest the localization of a general condition? Is not the same consequence seen in adenitis? We have often seen in the Ricord Hospital the transformation of venereal adenitis—inguinal and crural—into tuberculous adenitis. Our master, Humbert, often drew our attention to this particular. The same law doubtless holds good for the transformation of gonorrhoeal orchitis in the tuberculous.

The rôle of the lymphatics in the pathogeny of infection of the epididymis is difficult to determine. We must simply keep in mind the fact that the lymphatic system is the chief route, not only for the propagation of, but for the subsequent destruction of the bacillus. Some hold with Malassez that the path of infection of the epididymis and testicles is found in the intercanalicular lymphatic spaces; others with Gaule, believe that propagation occurs along the canalicular epithelium of the seminiferous tubes; still others regard the ordinary blood vessels as the route of invasion. New researches are required to shed light on these points of pathogeny.

The frequency with which one epididymis becomes infected when the other has been removed for tuberculous disease, prompts inquiry as to how such a form of recurrence is brought about. Infection must either occur through the prostate, or else both epididymes must have been infected from a common focus seated about the prostato-vesicular region. Both these possibilities could occur simultaneously. However this form of propagation takes place, it is necessary to protect the second testicle by ligating its own cord.

We shall not consider in this connection the epididymo-orchitic tuberculosis of childhood. Here we know that peritoneal infection is common; also that the haematogenous route is more likely to be a factor in the child than in the adult. We know, further, that in the child the testicle is attacked more commonly than the epididymis. Chronic tuberculosis is more benign than in the adult, it terminates

more readily in suppuration, and is more likely to end in resolution, without relapse or generalization. It is the same, in fact, in the child as is joint tuberculosis—often merely an external and local malady.

TREATMENT.

1. *Castration*:—This operation has always been performed, for it was long believed that a tuberculous testicle was a form of cancer, or that it would become cancerous in time. Abandoned as a result of the teachings of Laënnec, it again came into vogue with modern antisepsis. Since 1892 it has again lost ground and is in a fair way of extinction, save in cases with numerous fistulae and profuse suppuration.

Castration, whether early or deferred, is not as radical a procedure as has been believed, for it is always done too late. It rarely happens that a patient will submit to this operation when he suffers from nothing more than a few nodules of the head or tail of the epididymis. As a rule he consents to operation only in primarily hypertrophic forms or when suppuration is profuse.

The doctrine that castration does away with the internal secretion of the testicle, I hold to be pure theory. How could a testicle thus diseased secrete anything of benefit to the organism? The excretory passage is obliterated, and infectious elements proceed from the tuberculous focus into the lymphatics and veins to contaminate the organism at large. As for the internal secretion it would likely be compromised as soon as the epididymis becomes nodular and the testicle filled with tuberculous granules. While spermatogenesis may be preserved at the outset it would rapidly become altered.[3]

If during the operation of castration the vas deferens is not excised to the point where it empties into the seminal vesicle a bacillary fistula is apt to result. Again, if the castration result without local sequelae, we may still within a short time observe the infection of the other testicle, as if the latter had transpired through the vasa deferentia, seminal vesicles and prostate. Such an outlook is most discouraging to both patient and physician, and thus it is natural that castration has at present but few partisans. Bardenheuer has had 28 relapses in 38 cases, and other authors have had a similar experience. I have seen one relapse follow complete ablation of the vas deferens.

Finally castration is no more able than conservative operations to afford uniform relief in cases of prostatic and vesicular lesions, save in cases of intense suppuration of the epididymis. As Longuet states,[4] castration is not a radical operation, for it may be followed by relapse in the stump, in the prostate and seminal vesicles, in the bladder, in the opposite testicle, in the bones and in the lung!

It is doubtless well in castration to save some portion of the testicle, however small. Dupuytren states that in his day many castrated individuals committed suicide or died of vexation; and many authors, including Malgaigne, Fualds, Pilcher and Pujol have mentioned the psychical disturbances which follow castration. Quite recently Vouillac has published a thesis on testicular prothesis (Paris, 1899).

2. *Simple Excision of all the Tuberculous Tissues*:—This is an old operation, dating back to the time of Astley Cooper and Curling. At the present day an exploratory incision with extirpation of the tissue found diseased is recommended by Lejars,[5] Koenig,[6] Poncet,[7] Delbet[8] and other distinguished surgical authorities. If the incision does not expose any diseased tissue, the albuginea is sutured. Recently Poncet and Delore[9] have insisted that lesions of the testicle and albuginea may be latent and that they may therefore pass unperceived during the preliminary orchidectomy.

3. *Epididymectomy*:—In 1880 Bardenheuer performed the first systematic total extirpation of the epididymis; his initiative was followed by a number of prominent operators including Duplay, Humbert, Lejars, etc., etc.

Total epididymectomy is based on the fact that the testicle proper is often healthy. This is not the rule—far from it, as we shall see later. The operation consists in resection of the epididymis, with preservation of the testicle intact. If the vas deferens is involved, funiculectomy is also practiced. Duplay asserts that this method is applicable to certain cases only, in which the testicle is implicated. In this form of intervention the whole epididymis is extirpated, although it may contain but one or two small foci of disease.

Atrophy of the testicle does not follow total epididymectomy to any notable extent. In one case we observed a change in the dimensions of the corresponding testicle, with compensatory hypertrophy of its fellow of the opposite side, six months having elapsed since the operation.

4. *Methodical Excision of the Tuberculous Nodules in the Epididymis*:—This operation, practised by Malgaigne, Jobert and other older surgeons is at present advocated by Duplay.[10] The technique consists simply in searching the whole of the epididymis and testis for tuberculous foci which are extirpated wherever found. Sometimes nothing is left of the testicle but an indurated lump, but this suffices for the moral gratification of the patient. The use of the curette belongs here and Quénu's[11] operation consists of an exploratory incision with extirpation of the caseous foci and contiguous indurated tissues

by means of the sharp spoon. The wound is then cauterized with chloride of zinc, and either unites by first intention or is tamponned with iodoform-gauze.

5. *Cauterization with the Hot Iron*:—This operation was originally described by Velpeau in 1851; but it was found that fistula readily resulted from this form of intervention. Verneuil used the cautery with such effect that his operation might be described as a "castration by fire." This operator even believed that the cautery produced the regression of prostatic lesions in 80 per cent of cases. Curettage may be combined with cauterization.

In regard to *interstitial injections*, the results have not been brilliant. Cures are stated to have followed the injection of camphorated naphthol, chloride of zinc, etc.

Simple medical treatment is of no avail—a mere avowal of our helplessness.

Involution of the tuberculous lesions has been observed after all the conservative methods of treatment, just as after castration. Is it not therefore wise to attempt to procure the atrophy of the tuberculous epididymis by ligature or division?

GENERAL CONSIDERATIONS UPON THE RESULTS OF SECTION AND LIGATURE.

As we intend to describe a new conservative method based upon ligature and section, undertaken with the intention of producing atrophy, to be followed by auto-grafting of the isolated organ, let us briefly review the results of these procedures in general. We regard such a study in physiology as absolutely indispensable, for it will show us how to proceed when ligation is to be applied to the testicle and epididymis.

We shall consider the results of ligation or section upon:—1. Healthy organs. 2. Organs, the seat of neoplasms. 3. Infected organs. 4. The testicle in all possible relations.

1. *General Historical Sketch of Physiological Ligature*:—Ligature and section have been practiced upon the excretory ducts, vessels and nerves of healthy organs since Saunders tied the ductus communis choledochus in 1775. Cooper, Curling and others ligated and divided the vas deferens in the first half of the 19th century and Claude Bernard tied the pancreatic duct in 1850. In 1867 Obolensky divided the spermatic nerves as well as the vas deferens. Several experimenters tied the hepatic artery in 1876 and four years later Arnozan and Vaillard ligated the ducts of the parotid.

In 1895 Alessandri performed individual ligature of each of the

afferent and efferent vessels of the testicle and of the nerves of the latter; forty experiments were reported. His work has been continued by others. In the same year Kaufmann showed that the pancreas and liver undergo atrophy if their nerve supply is cut off; while in 1898 Alessandri demonstrated that atrophy of the kidney occurred whether its artery or its vein was ligated.

2. *History of Ligation in Connection with Organs the Seat of Tumors:*—Harvey himself in 1651 ligated the spermatic arteries for elephantiasis of the scrotum and testicle and for tumors involving the latter, with favorable results. Broca therefore terms him the father of this method in surgery. Lange in 1707 suggested the wisdom of imitating those veterinary surgeons who divide the arteries in strumous tumors. Early in the 19th century ligation of arteries for tumors was practiced by several surgeons including Maunoir, who tied the spermatic arteries for "sarcocele" in 1815. The various recorded facts in regard to ligation, etc., have become too numerous for repetition in this connection; suffice it to say that ligature of the cord, vasectomy, etc., to produce atrophy of the prostate became legitimate surgical procedures about 1895. Bier had previously sought to cure hypertrophy of the prostate by tying the hypogastric arteries (1891.)

3. *History of Ligation, etc., for Infected Organs:*—In 1862 Skey tied the spermatic cord in a case of tuberculosis of the testicle, because he feared the result of castration in a cachectic subject.

Bier, by his well-known method of venous compression has caused the disappearance of "white swellings"; this compression is of course equivalent to temporary ligature.

In 1897 Tuffier compressed the pedicle of a suppurating kidney with retention-forceps, and the affected organ was eliminated through the wound.

The work of Skey, Bier and Tuffier leads up to the method advocated by the author.

ATROPHY OF GLANDS BY LIGATION OR DIVISION OF THE EXCRETORY CANAL.

There is enough evidence on record to show that, as a general proposition, ligation of the excretory duct of a gland will produce atrophy of that organ. For example, Arnozan and Vaillard have shown that ligature of Steno's duct will bring about sclerosis and atrophy of the parotid.

If we apply this principle to the testicle we should consider the effects of all possible forms of obliteration, whether teratological, pathological or physiological; and we must consider the results of

such obliteration upon both the internal and the external secretion of the testicle.

a. *Teratology* teaches us that the vas deferens may be absent, although atrophy of the testicle and epididymis does not coëxist. In Brugnone's case the spermatic passages were obliterated from the middle of the epididymis to the bladder; nevertheless the remainder of the epididymis and the testicle had not undergone atrophy and were found to contain spermatozoids.

In Gosselin's patient the funicular portion of the cord together with the inguinal portion (about 10 cm. altogether) was absent. The testicle, however, had undergone no alteration in size or appearance, and also contained spermatozoids.

b. *Physiological ligature and division of the deferent canal* has frequently been practiced. Brissaud, writing in 1880, states that these procedures do not cause cirrhosis and atrophy of the testicle. The corpus Highmori appears to protect this organ in some way from the inflammatory alterations which lead up to cirrhosis. The epididymis undergoes inflammatory change, and if the experiment animal is left with the females, spermatogenesis occurs in an exaggerated fashion, with subsequent return of the testicle to the embryonal state. But when the animal is isolated, ligature of the vas deferens is followed by no changes in the testicle.

The results of other experimenters in this sphere have been conflicting and quite recently the subject has been investigated anew. In 1895 Alessandri [12] decided that ligature of the vas deferens would eventually produce atrophy of the epididymis and testicle. There is, at first an increase in the amount of connective tissue, but a process of sclerosis eventually leads to the disappearance of the canaliculi. In the epididymis, the first permanent alteration consists in a loss of the cilia, the epithelium assuming the simple type.

c. *Pathology* teaches us that the vas deferens may be obliterated as a result of any of the forms of orchitis, yet this obliteration is not necessarily followed by atrophy of the epididymis and testicle. Bardenheuer and Englisch have each noted the fact that extirpation of the vas deferens and epididymis (for tuberculosis) is not followed by atrophy of the testicle, while Griffiths has observed a slight atrophy under these circumstances. Generally speaking the effects of pathological obstruction of the vas deferens have been conflicting.

ATROPHY OF THE ORGANS AS A RESULT OF ARREST OF THE ARTERIAL CIRCULATION.

1. *Generalities*:—Arterial ligation has been practiced in both healthy and diseased conditions (tumors). Curling saw atrophy of the testicle follow ligation of the spermatic artery; while Wardrop reported two cases in which atrophy of this organ followed the obliteration of the arteries incidental to the presence of aortic aneurism. Miflet[13] showed by numerous experiments upon the dog that ligation or embolism of the spermatic artery gave rise to haemorrhagic infarctions of the testicle which were followed in turn by a sclerotic atrophy. Arrest of the circulation of the spermatic and deferent arteries induces atrophy of the epididymis.

From numerous published accounts of the results of ligation or division of the spermatic arteries, it is evident that great disparity exists, some authors reporting no atrophy whatever, others partial atrophy, complete atrophy and gangrene respectively. There is, however, plenty of evidence that such ligation does produce atrophy on a great many occasions.

There are a few recorded cases in which ligation of the spermatic artery for some disease of the testicle has caused atrophy of the latter organ. The author's experience will be detailed later on.

ATROPHY OF THE TESTICLE AND EPIDIDYMIS AS A RESULT OF ARREST OF THE VENOUS CIRCULATION.

Here, as elsewhere, the published reports are conflicting. It is certain that the obliteration of the spermatic veins incidental to the operation for varicocele is practically without effect upon the testicle, although a few authors claim that a slight atrophy of the organ results. Phlebitis of these veins has caused profound alteration in the testicles, but here a condition of septic infection of the latter is to be inferred. The author's experience is to be found farther on.

ATROPHY OF THE TESTICLE BY SIMULTANEOUS ARREST OF BOTH THE ARTERIAL AND VENOUS CIRCULATIONS.

Curling, Pott and others have noted the occurrence of the fact that simple compression of the vessels of the cord by a hernia has determined an atrophy of the testicle. Similar compression by the dilated veins in varicocele may have the same effect. Numerous experiments have shown that division or ligation of all the vessels of the cord at once may cause simple atrophy or necrosis. In 1895 Alessandri claimed that this result was inevitable. If the deferent

artery were left intact, atrophy still took place, although more slowly. The process of atrophy was preceded by coagulation-necrosis.

If in the operation of obliteration of the veins for varicocele the spermatic artery is accidentally severed or is tied, atrophy of the testicle is of frequent occurrence. Tillaux claims that if the funicular and deferent arteries are left intact the nutrition of the testicle is maintained.

In 1897, Albarran and Motz[14] resected portions of all the vessels and nerves in the cord, with the exception of the deferent artery and its veins. The vas deferens was left intact. In two such experiments upon dogs the testicles were found completely atrophied at the end of three months. It must be borne in mind that in these experiments the nerve was severed.

ATROPHY OF THE TESTICLE AFTER LIGATURE AND DIVISION OF THE NERVES.

We know that various lesions of the cerebrum, cerebellum and medulla have provoked atrophy of the testicles, although the rationale of this sequence has been much discussed. Division or resection of the spermatic nerves also determines an atrophy of the testicle. Certain observers, however, have encountered an atrophy of the prostate, but no change in the testicle, after this experiment. Alessandri found that excision of a portion of the nerves brought about necrosis of the testicular epithelium.

The author's experiments will be detailed later.

ATROPHY OF THE TESTICLE AFTER LIGATURE OR SECTION OF ALL THE VESSELS AND NERVES OF THE CORD.

Total ligature of the cord has been known to produce gangrene of the testicle in the dog. In a human prostatic subject, total section of the cord was followed by a diminution in size of the testicle by one-half. Generally speaking, the results in this class of experiment or surgical intervention have been contradictory.

THE AUTHOR'S RESULTS IN TOTAL DIVISION OF THE CORD IN TUBERCULOSIS OF THE TESTICLE AND EPIDIDYMIS.

It is probable that when aseptically performed, the result of this intervention is always an atrophy, never a necrosis of the testicle. An incidental effect of this division of the cord is the protection of the opposite testicle from tuberculous infection, while lesions of the prostate and seminal vesicles may be thereby influenced towards resolution.

Technique: a. *Resection or simple section between two ligatures*:— We first make an inguino-scrotal incision for the purpose of exposing

the cord. Two strong catgut ligatures are then placed upon the latter. The superior ligature is placed against the external orifice of the inguinal canal, the cord being lightly drawn outward. After division of the cord between the ligatures the cut ends are cauterized with the thermocautery. The wound is cleansed with sublimate and the lips of the cutaneous wound sutured, as a rule without drainage.

In a few of our earlier cases we resected about 2 cm. of the cord, the inferior ligature being placed very low. This technique was abandoned, because several arterial twigs were destroyed which would have been of service in the consecutive grafting of the testicle.

General or local (cocaine) anaesthesia was employed in the author's cases. The subcutaneous ligature was found to be practicable, but this resource was not used lest the continuity of the vas deferens should be reëstablished—a result which has been recorded in the cases of the common bile-duct and pancreatic duct.

b. *Section between two ligatures, combined either with curettage, or open incision, or the use of the thermocautery.*

In addition to the section of the cord the author has several times practiced curettage of the tuberculous focus in both suppurative and non-suppurative cases and with or without fistula. When a scrotal fistula was present, it was curetted in its continuity, or the entire epididymis was scraped, while the testicle was drawn out through the inguino-scrotal incision, originally made for ligation and division of the cord. Since simple division will not quickly produce atrophy of the suppurating and fistulous gland it was thought best to resort to curettage of the diseased foci at the same time. The presence of small foci of tubercles in the tail of the epididymis, unrecognizable by palpation, often explains why ligature alone is insufficient to produce atrophy promptly. These *small, latent, cold abscesses* have been encountered by us with greater frequency than authorities admit. However that may be, we always cauterize them well, after we have drawn the testicle out of the wound to protect the latter from the pus. The field of operation is then carefully wiped dry, and thus ascepticized, the testicle is replaced in the scrotum, provided a scrotal fistula does not coëxist. This method of procedure is not followed by scrotal suppuration.

When, however, a scrotal fistula is already present, the act of opening the scrotum for the purpose of cauterizing the epididymis, is combined with incision and "marsupialization" of the fistulous tract, and gauze-drainage is made by the latter. Under these circumstances suppuration is abundant after the operation, and some necrotic frag-

ments are expelled. A fibro-glandular mass is left in the scrotum after resolution has occurred, which gives satisfaction to the patient and surgeon, although it may produce scarcely any secretion, external or internal.

It is especially in cases of massive and hypertrophic tuberculous lesions of the epididymis that we have done centripetal cauterization over the entire organ with the fine point of the thermocautery, the entire mass having been drawn outward through the inguino-scrotal incision. This procedure should not, however, be carried too far.

We have made trial of the method of *exposure of the tuberculous lesions.* Everyone is aware, of course, that by this empirical resource, tuberculous peritonitis has been cured, this result taking place only in ascitic cases—about one-sixth of the patients recovering. We have laid bare the tuberculous foci in the epididymis by an incision made either above and corresponding to the nodules in the head of the organ, or below and corresponding to the tuberculous foci in the tail. If the whole structure was affected the incision made, was of the longitudinal and external lateral type, designed in such a manner as to avoid exposing the testicle, which might lead to a fungus of the latter organ. In one case in which we involuntarily exposed the testicle, a fungus was doubtless prevented by suturing the albuginea. In another case, wishing to prolong the exposure of the tuberculous foci to the air, we did not suture the albuginea. The wound dressing was insufficient to retain the testicle and epididymis in the scrotum and elimination of the gland resulted.

In a patient with suspected tuberculosis of the epididymis, we operated despite the coëxistence of pulmonary lesions, by simple epididymotomy, antero-posterior section. Atrophy of the gland and epididymis set in very rapidly, and one month later these structures were reduced in size to the volume of a small nut. How does the testicle exist after separation from its cord? Whence come the new nutrient vessels? The testicle persists and is nourished because of the adhesions which it forms with its envelopes. Its blood supply comes henceforth from branches of the external pudic alone. Of these branches some proceed as far as the fibrous tunic, there to anastomose with the visceral terminals of the spermatic and deferent arteries; while others irrigate the organ to a very slight degree through its inferior ligament. Finally, branches of the cremasteric artery anastomose with the funicular branches of the spermatic. If the cremaster has not been too much torn, there is still an arterial route which can form anastomoses in case of complete division of the vessels and nerves of

the cord. In our more recent operations we have ruptured the cord longitudinally for a short extent, whereupon its vessels prolapse and are ligated by themselves, the remainder of the cord being left intact.

Finally the scrotal ligament which is half fibrous and half muscular and extends from the posterior pole of the testicle to the scrotum, (it is really a vestage of the gubernaculum testes) contains some anastomotic vessels (Charpy)[15]. These may assist in forming a compensatory collateral circulation, thereby favoring the grafting of the testicle in cases in which the cord has been completely severed.

Immediate results of complete division of the cord. When we are dealing with a case of non-suppurating tuberculosis, a slight degree of swelling and tenderness is noted on the day following the operation. We have occasionally seen the temperature rise as high as 38° C. But fever is an inconstant phenomenon and the conditions under which it occurs are as yet undetermined. It is possible that the chloroform causes an exacerbation of the pulmonary lesions which may coëxist in these cases.

In our more fortunate cases, atrophy of the testicle is in evidence as early as the fifteenth day and persists during the succeeding interval. The normal tenderness to pressure disappears completely at the very outset.

In cases of tuberculosis accompanied by small, cold abscesses—fistula being as yet undeveloped—the results are the same if the focus has been well cauterized and asepticized.

In cases of *suppurating* and *fistulous* tuberculosis the results are less brilliant. The post operative swelling persists for a longer period, the testicle becomes painless to pressure, the fistula persists for a long time and repeated use of the curette may be required. Eventually, however, the epididymis and testicle undergo atrophy. The most discouraging feature in these suppurative cases is the abundance of the pus and the chronicity of the affection whenever it has been necessary to resort to multiple cauterization.

The fibrous residue which remains after resolution has occurred is satisfactory to the patient and is a good substitute for the artificial testicles employed after castration.[16]

Does the persistence of the fistula indicate a prolonged necrobiosis of the epididymis, such as is seen in the spleen after ligation of its vessels? In any case we thought best not to excise the fistulous tracts, hoping to conserve as much as possible of the genital mass.

An attempt should have been made to ascertain if Koch's bacilli were present in force in the fistulous pus after division of the cord.

The most successful of our cases is that in which we ligated the cord on both sides with the exception of the vas deferens, deferent artery and the small veins which accompany the latter. On the left side there was no fistula; and after ligation we proceeded to cauterize the bacillary nodules, one of which was suppurating. The entire mass was replaced within the scrotum. By the eighth day the testicle and epididymis had diminished in size by one third; and by the end of the third week, by one-half. At a later period two small purulent foci were eliminated. On the right side the testicle was fistulous and suppurating. After ligation, I applied the curette and the fine point of the thermocautery. The mass formed by the testicle and epididymis rapidly diminished in volume, and the fistula closed completely by the twenty-fifth day.

The only accidents seen by us in these cases consisted of haematomata of considerable size which suppurated. Was this an operative shortcoming, due to insufficient haemostasis, when the cord was separated from its envelopes? The pulmonary lesions which coëxisted, and which were suppurative in character, may have readily produced suppuration of these haematomata. As these patients have microörganisms in their blood, the cause of suppuration may have originated within. It is thus that Vanverts explains those suppurations of the spleen after ligature of its vascular pedicle. However this may be, the frequency with which these haematomata occur, together with the frequent occurrence of suppuration of the wound when an abscess of the testicle is present, has influenced us in our more recent cases to drain the wound high up.

Hyperthermia has been noted after the operation, even in one case with aseptic evolution. In the only histological examination which we made in a patient who died of pulmonary tuberculosis, M. Delamare ascertained that the seminiferous tubes were normal in number and dimensions, while their epithelium was intact. There was no hypertrophy of the interlobular connective tissue.

The advantages of our method of isolating the testicle are very great, if, as Villard believes, one-half of the patients with genital tuberculosis have their lungs intact. From the same point of view it would be interesting to know what proportion of patients with testicular tuberculosis have tubercles in the prostate or seminal vesicles.

Be that as it may, the tuberculous testicle, thus isolated and grafted, is no longer a menace of infection to the organism at large. It also seems to us that this isolation has favored, in certain cases, the spontaneous cure of the vesicular and prostatic lesions. It probably

also averts recurrence of the disease in the opposite testicle, which, however, as a matter of precaution should have its vas deferens ligated.

As for the genital functions they are amply preserved, as shown by the testimony of our patients.

[TO BE CONCLUDED.]

REVIEW OF CURRENT LITERATURE.

ON THE SPREAD OF PHTHISIS BY COUGH-SPRAY AND THE DUST OF DRIED SPUTUM.

Heymann, *Zeitschrift für Hygiene und Infectionskrankheiten*, 1901, Bd. XXXVIII, No. 1, speaks of the increasing interest in the subject of infective spray. Koeniger made especially thorough researches in human beings with cultures of the bacillus prodigiosus, placed in the mouth, the effect upon the spray by the most diverse forms of speech having been studied. The maximum projection of the spray was caused by the articulation of the consonants *p*, *f*, *k* and *t*. Laschtschenko also studied the degree of diffusion of the droplets by speaking, coughing, and sneezing. In one instance it required but two minutes for an entire room to become infected from the spray of a single individual.

Even after speech in a low voice the walls of the room showed evidence of contamination, not only in front of the experiment-individual, but behind and at the sides as well. Koeniger has also studied the duration of the suspension of these infected droplets in the air. He found that the air was free from them after one or at most two hours. When instead of the prodigiosus a larger germ was chosen (the bacillus mycoides) the precipitation occurred much more rapidly. These results differ from those obtained by Flügge with artificial spray which remained suspended for five hours. This difference may be due to various causes, such as the actual degree of moisture of the air, the possibly different behavior of water and saliva under the same circumstances, the manner in which the spray is produced and the size of the microörganisms. That this latter element exerts considerable influence we know from the results of the work of Buchner, Megele and Rapp in 1899.

Koeinger, who found that natural spray was projected to such great distances, has been corroborated upon this point by the recent

work of Kirstein and Hutchison; the former traced the culture beyond the confines of the room, and practically through the entire building in which the experiments were performed, even to a distance of 600 meters.

None of the experimenters along this line have made use of the tubercle bacillus. The authority of Cornet places the danger of infected spray far beneath that of infected dust, for this authority regards the line of experiment pursued with artificial sprays as highly unrealistic. This point of view doubtless represents the opinion of the majority, for we nowhere find much account made of infected spray under the head of prophylaxis.

Minor experiments have been made with tuberculous spray upon objects placed near the mouth of a patient while the latter spoke or coughed, and prophylactic suggestions have been advanced, based upon the character of the findings; but as just now stated the broadcast diffusion of the tuberculous spray has thus far never been studied.

Cornet's deductions from the infectiousness of dried sputum, the latter being admitted, cannot be regarded as proven any more than the claim of the infectiousness of spray. His experiments are open to the charge of exaggerating natural conditions. The present author has therefore undertaken new researches into the subject of the broadcast diffusion of the tubercle bacilli by both infected spray and infected dust.

He first investigated the limits of diffusion of cough-spray in a given room. It was first found that a consumptive under perfectly natural conditions rarely projected his cough-spray for a greater distance than a meter. This being the case it is not difficult for a healthy individual to keep out of the range of the spray. It was moreover ascertained that a handkerchief held before the patient's face was sufficient to reduce the maximum limit to 80 cm.

However this experiment only traces the tubercle bacillus for a short interval, and the important question of the wanderings and ultimate fate of the germ demand further research of a different character. The question first to be answered is, "how long do the germs remain floating in the air." The table in the original article shows that the interval varies from 15 minutes to 1½ hours.

The second question relates to the fate of the bacilli after the fall to the floor, and is easily answered. After the tiny particles of spray become dry the microörganisms undoubtedly rise with the ordinary dust and settle on the furniture. Another question therefore arises, viz.—"what is their tenacity of life under these circumstances"? To

secure material the author made use, in part, of an artificial spray. His tabulations show positive results in a fair number on the second and third day and exceptionally as late as the 12th and 18th day. These exceptional instances of survival occurred invariably in experiments with darkened room.

Heymann now made comparative series of researches with the dust of dried sputum. He investigated the manner in which the dust is produced, the interval during which it floats in the air and the behavior of the dust under aspiration. He also investigated the air in rooms occupied by consumptives under natural conditions, both in hospital and private dwellings. He is then in position to make a statement as to the comparative risk of infection from spray and dust. He repeats the maxim in this connection—"seek the enemy where he oftenest appears." As to the constancy of the production of infected spray by the tuberculous, he admits that there are circumstances under which the danger of infection becomes minimized; thus some patients do not project infected spray during the warm summer months. Doubtless there are periods in the life of any consumptive in which his spray is free from virulence. It has already been stated that the distance of propulsion in coughing rarely exceeds a meter, but this space between the infected and the healthy cannot be maintained in the relations of private life such as those of mother and child, or even in the intercourse of many workshops.

But when we come to the question of infected dust, the formation of such a product is only an incident in the history of a consumptive. It is possible in dirty private dwellings, but should not occur elsewhere. When such dust is formed its heaviness causes most of it to sink quickly to the floor, only a minimal quantity remaining suspended in the air. Cornet's experimentally generated dust is a gross exaggeration of natural conditions.

Much more just is the criterion of testing the air of the suspected room. It is undoubtedly true that under particular circumstances in factories, shops, railway-cars, in fact wherever men assemble in close quarters, that a fine dust, capable of floating in the air, may be formed in sufficient quantity to infect the air of the compartment. But such a state of affairs could hardly occur in hospitals and private dwellings.

THE SPREAD OF TUBERCULOSIS BY COUGHING.

L. Napoleon Boston, *Journal of the American Medical Association*, Sept. 14, 1901, has reported an interesting series of practical experiments, undertaken by him in the Philadelphia Hospital with a view of determining whether or not consumptives emitted a fine spray when talking, laughing, clearing the throat or by their characteristic hacking, which might in any way be dangerous to the health of their associates. Fifty patients, in all of whom unquestionable evidence of either pulmonary or laryngeal tuberculosis existed and in whose sputa tubercle bacilli had been found, were employed in the investigation of the question. The methods pursued by Boston were as follows:—The spray was collected by means of a mask made of wire and arranged to hold two microscopic slides directly in front of the nose and mouth, at a point three inches distant from the lips. The patients were instructed to wear the mask from one to one and a half hours at that period of the day when apt to cough least. The mask was not worn during the morning or evening because of the usual tendency to the occurrence of paroxysmal coughing at these times of the day and the patients were directed during paroxysms to remove the mask.

On microscopical examination of the fifty specimens obtained from these 50 patients 38 were found to contain tubercle bacilli, from 4 to 6 bacilli being the smallest number found in any specimen, while many of them presented fields in which tubercle bacilli were too numerous to be counted. In addition to tubercle bacilli other bacteria were observed, viz.—bacilli, clusters of cocci, and most constantly diplococci, and streptococci. Small squamous epithelium, small epithelial cells and leucocytes were also found.

By the use of the low power objective very fine droplets, invisible to the naked eye, were located upon the slide and in these with the 1-12 oil emersion numerous tubercle bacilli were frequently demonstrated.

From patients, the subjects of laryngitis, and from those who talked loudly or frequently cleared their throats, the most spray was emitted. In patients who were very weak, speaking only in a whisper scarcely any spray collected on the slide and this seldom contained tubercle bacilli.

Men with heavy moustaches ejected no spray on the slide until after the moustache was held from falling over the mouth.

Coughing with mouth open of course favored the production of the spray.

The author suggests that infection of open wounds during surgical operations may occur by such ejection of spray in instances in

which those performing the operation or assisting, are the subjects of either acute or chronic infection of the mouth, throat or respiratory tract and in conclusion says—"The advisability of all persons being provided with a mask of gauze on entering the operation-room, to prevent all possibility of their contaminating the air of the room, would appear from a bacteriologic standpoint to be a rational procedure, yet before this precaution can be urged, it too, must be tried by the surgeon and shown to lessen the number of cases of infection for which at present no ascribable cause is given."

ON THE PENETRATION OF BACTERIA INTO THE LUNGS THROUGH INHALATION OF SPRAY AND DUST.

Nenninger, *Zeitschrift für Hygiene und Infectionskrankheiten*, Bd. XXXVIII, No. 1, 1901, has made numerous researches upon animals in this direction, the gist of which may be found in the abstract of an article by Prof. Fluegge in this number. He has also considered this subject in its relationship to mankind, naturally from a somewhat different point of view; as experiments in the human species could hardy be undertaken.

We know from autopsies that bacteria are able to penetrate into the deeper bronchioles. Besides if the germs could enter the tiny breathing tubes of a guinea pig, how much more readily could they be received into the respiratory tract of a man, where the rapidity of the air current is much greater.

We must bear in mind how large the number is of men who are forced by their occupation to breathe bacteria-laden air.

It is easily possible by forced inspiration to cause the transfer of bacteria from the mouths of experiment-animals into the lungs, and men should be exposed to the same liability.

It has been abundantly shown that the expiratory current is permeated with bacteria-laden droplets which are diffused through the acts of speaking, coughing, etc. The inspiratory stream should likewise contain this infected spray. This stream should readily succeed in bearing particles of fine spray from the mouth into the deepest passages. The nasal secretion, however, from its tenacity does not readily lend itself to droplet-formation. But we must not forget that at the onset of a coryza there is a period at which the discharge is extremely thin and watery.

Droplet formation is thought to occur most naturally at the oral portion of the throat, where the respiratory and digestive tracts meet; in general any portion of the upper passages in constant movement—as in swallowing, speaking, coughing, sneezing, yawning, etc., is calculated for droplet formation, because it is in such localities that bridges and membranes of secretion form, which are broken up into spray by the out and incoming currents of air. Hence we must include among these localities the vocal cords, back of the tongue, palatal arch, uvula and posterior wall of the pharynx.

The germ contents of the mouth are therefore a menace to the lungs; and conversely the sputum of the tuberculous, contaminating the mouth, becomes a menace for those who live in close relations with the patient.

TUBERCULOUS INFECTION THROUGH THE AIR PASSAGES.

Thomson, *The Practitioner*, July, 1901, begins a paper on this subject with the query, "why is the nose so seldom attacked by tubercle?" Autopsies show that it participates with pulmonary tuberculosis but once in 450 times.

Our knowledge of the hygienic importance of nasal respiration has only been recognized for the past 15 years. The vibrissae act as a sort of *chevaux de frise* in arresting the bacilli at the entrance into the nose. The sticky mucus entangles those microörganisms which succeed in passing the first obstacle. The ciliated epithelium is a third antagonist, while finally phagocytosis destroys such invaders as succeed in getting past the other hindrances. But even this is not all, for during lachrymation a flow of tears enters the nasal chambers, and the act of sneezing is also efficacious in ridding them of any foreign particles which may chance to be present.

In the few recorded cases in which tubercle bacilli have been reported as present in the nose, the material for culture was doubtless taken from anterior nares. Mucus well within the nose is always practically sterile.

Recently Renshaw has introduced tuberculous sputum into the nasal chambers of guinea pigs with the usual result that infection appeared *in situ*.

A strange fact was the failure of the occurrence of secondary deposits in the brain and thorax, the viscera alone having been implicated.

The author has recently studied a case of primary tuberculosis of

the nose. He believes that it represents the first recorded case of this localization in Great Britain, but a number have been published since, Dr. Steward having reported a series of six. The lesion takes the form of a granuloma at the anteror portion of the septum.

To take up the subject of tuberculous infection in general, the mode of propagation in a given case should be one of four, viz., accidental inoculation, hereditary transmission, ingestion by way of the alimentary tract and inhalation through the respiratory tract. Naturally from its title the author's paper must be limited to a consideration of the last named cause.

That germs could ever be aspirated directly into the alveoli of the lungs is contrary to all physiological teachings; there are far too many barriers in the way, and even if these should be surmounted the air-cells contain a considerable amount of still residual air. The torn pleural cavity is naturally sterile, while expired air is likewise free from germs. Hence when bacilli enter the upper passages we must seek for some natural port of entry in which a foothold is obtainable. The first locality to investigate is the tonsillar tissue, especially when the seat of hypertrophy. An abundance of available statistics appears to show that something like 5 per cent. or 6 per cent. of adenoids show tuberculous infection. The very large surplus of negative results cannot outweigh the significance of these negative findings.

In regard to the faucial tonsils, they are more frequently infected by tubercle than are the postnasal adenoids, the ratio being at least two to one. Experiments have abundantly shown that insoluble coloring matters pass from the tonsils into the lymphatics and general economy.

Primary infection of the larynx is most difficult to determine. It is known to have occurred in extremely rare cases, and we also know that in the great majority of cases the lungs must first be infected. The approximate frequency of primary implication cannot, however, be ascertained. The author quotes the saying of Jonathan Wright that the "bacillus must be baptised in the lungs and born again before it is able to overcome the resistance of the larynx." The act of swallowing has a cleansing effect upon the larynx, for the cords are thereby compressed together and mucus from the ventricles is forced to flush them, so to speak, toward the oesophagus.

Everything points to the "cross-roads" where the air and food passages meet, as a source of danger from tubercle; because just here is seated the "tonsillar ring." In this connection should be mentioned the frequency with which the middle ear is affected in tuberculosis.

THE COMMUNICABILITY OF HUMAN TUBERCULOSIS TO CATTLE.

Dr. Sheridan Delipine, Professor of Pathology in Owen's College, Manchester, publishes an experiment upon four calves with the view of the further elucidation of this question, *British Medical Journal*, Oct. 26th, 1901. Believing that different degrees of virulency existed in tubercle bacilli from human subjects, the author obtained from different patients sputa which contained tubercle bacilli: 1st:—Long slender forms showing typical melachromatism; 2nd:—Thick forms staining almost uniformly; 3rd:—Short forms occurring in clumps; 4th:—Short forms staining badly. These sputa were mixed, and the calves were inoculated therewith—one directly into the lungs, one under the skin, one intra-peritoneal, 5 c. c. of the sputum being injected in each case; another was fed 50 c. c. of the mixed sputa in a single day.

The author refrained from the tuberculin test, fearing that possibly induced immunity from the tuberculin might jeopardize the result, and preferred to depend upon the evidence of extension of the disease from the locality of infection for his demonstration of successful inoculation if this should actually take place.

The results were on the whole not as satisfactory as was hoped for, because calf no. 1, injected into the lung, died on the sixth day from other infection introduced with the sputum and proved on autopsy to have been tuberculous before. Calf no. 2 suffered a like fate; an enlarged and inflamed lymph ganglion, situated about 5 inches from the point of infection, contained tubercle bacilli which proved virulent in guinea pigs. The author, while rejecting the experiment, thinks that this case might fairly be given as an instance of rapid infection of lymph ganglia, supported by the result in the guinea pigs.

The third calf which was fed 50 c. c. of the mixed sputum showed signs of illness 2 weeks later, had diarrhoea and died 26 days after inoculation, and after having received a test dose of 10 minims of tuberculin less than 8 hours before death. The post mortem examination showed semi-purulent peritonitis, enlargement and softening of all the mesenteric glands, and of other lymph-ganglia connected with the alimentary canal. No tubercle bacilli were discovered in the lymph-ganglia. Inoculation was positive in one pig, which was inoculated from the oesophageal gland, another died rapidly; two others gave no external evidence of the disease.

The author concludes this case to be of considerable interest,

although the death was not caused by tuberculosis, but apparently by the same bacillus which killed calves no. 1 and 2, and which was the chief cause of the pathologic changes found in the lymphatic ganglia connected with the intestines.

The state of these glands made it difficult to find tubercle bacilli, but the fact that there was no evidence in any other part of tuberculosis, and one of the pigs died of tuberculosis due to the inoculation, causes the author to attach a belief of strong probability that the tuberculosis of these glands was caused by the ingestion of tuberculous sputum.

The fourth calf was inoculated on Aug. 1, intra-peritoneal; the inoculation was followed by swelling of adjacent gland (4 inches distant) and irregular rises of temperature. On August 26, this animal was tested with tuberculin, which test was followed by a rise of 1° F. and the previously enlarged gland increased in size and became tender, but afterward resumed its previous size.

On October 15, the temperature had become more regular and another tuberculin test (15 minims) was applied. To this the calf responded with a rise to 106.2° F. receding to 103.8 in 24 hours; three days thereafter it was killed.

The post-mortem examination showed no typical tubercles in the aforementioned enlarged gland; several cheesy, tuberculous masses were found in the large omentum, numerous tubercles in the pelvic peritoneum, miliary tubercles in the suspensory ligament of the liver. in the parietal peritoneum behind, in the diaphragmatic above, in the spleen; the parietal peritoneum in both iliac regions was thickened, rough and covered with small fleshy tuberculous looking nodules, and small polypoid masses (resembling young grapes); the mesenteric and retro-hepatic glands and 2 sacro-iliac ganglia were enlarged. A few tubercles were present in the capsule of the liver, and in the peritoneal covering of the spleen. Small fleshy tubercles were found in the pleural cavity most abundant in the diaphragmatic pleura above the spleen; also rows of small tubercles along the lymphatics in the intercostal spaces up to 5th rib, but only a few above that level. Lungs and pulmonary pleura were free, the pericardium was slightly affected but around the large vessels at the root of the heart it was almost entirely covered with a layer of small rounded fleshy tubercles; bronchial glands slightly enlarged, but not tuberculous. Tubercle bacilli were demonstrated in omental tubercles and in the retro-hepatic ganglion; none have so far been discovered in the mesenteric, oesophageal or bronchial ganglia.

Guinea pigs inoculated from several of the lesions, showed at the end of 9 days evidence of beginning tuberculous infection.

The author concludes that this experiment can leave no doubt as to the source of the infection, all lesions being clearly connected with the peritoneal infection, having the same distribution as those found in rabbits and pigs infected with tuberculous products from human or bovine sources.

[We doubt that the author has made out a case. In animal no. 2, the inoculation experiment simply shows that the bacilli injected were virulent and were absorbed into the gland, which, when inoculated into a pig caused characteristic effects. The same is true of animal no. 3; some of the ingested tubercle bacilli had evidently been absorbed but they failed to produce tubercles in the calf; but when transplanted into the guinea pig from the tissues of the calf they proved still virulent. These two cases not only fail to justify the author's inferences, but supply strong proof in support of Professor Koch, for it should ever be born in mind that the presence of tubercle bacilli in tissues, no matter where found, does not constitute tuberculosis, but that the actual histologic tubercle only, can be so interpreted. In the fourth case, the actual tubercle was evidently present, but here is the serious element of doubt, arising from the possible presence of tuberculosis, prior to the inoculation, or to the presence of bovine tubercle bacilli in the milk with which the calf was fed. We should prefer to take the latter views and to attribute to the inoculation, only the inflammatory changes that were found in the peritoneal and chest cavities, and which were evidently not of a tuberculous character.

The author was just as likely to have selected two tuberculous calves, as one, and had the first one not died as early as it did, and had it been inoculated into the peritoneal cavity as was the fourth, identical conditions would probably have been found.—Editor.]

THE INFLUENCE OF THE BACILLUS IN PULMONARY TUBERCULOSIS.

The above is the title of a paper contributed to the *Medico-Legal Journal*, June, 1901, by Dr. Hubbard Winslow Mitchell and read by the author before the Medico-Legal Society and the American Congress of Tuberculosis, last May.

The author states that "the idea seems to be everywhere accepted that no case of lung disease can be called tuberculosis unless it shows the presence of the bacillus of Koch, but if we accept it then a great number of cases of lung disease in which the sputum shows no bacilli,

are not tuberculosis." This was for a long time Dr. Mitchell's belief, but the microscopical examination of the sputa in 675 cases of pulmonary tuberculosis personally observed by him during the past five years, showed that the clinical course of the affection is essentially identical whether tubercle bacilli are found or not, and regardless of the number of germs present. By these observations the author was impelled to question the specific action of the tubercle bacillus in producing pulmonary tuberculosis. He was led to the opinion that "ulcerative disease of the lungs" would be a better term than pulmonary tuberculosis in case it could be shown that the bacillus does not induce the disease; furthermore his attention was directed to the pus-cell as the "carrier of the special toxic principle of this disease." That the pus-cell and not the bacillus was the exciting cause, he believed because "cases where no bacilli or few bacilli were present were identical; therefore the cases where they did not exist could not be due to the bacillus," and therefore some other cause must be productive of the disease. Since the pus-cell is always present, the author looks for the etiological factor therein, and states that "the pus-cell which is the carrier of disease in other maladies must be the carrier of the disease in pulmonary tuberculosis." In support of this statement he says "If we look through the microscope at a properly stained specimen of tuberculous sputum, we see one or more or no bacilli. When met they are very minute in size and seem incapable of setting up the mischief we find in a diseased lung, but the same field under the microscope is always crowded with pus-cells." In conclusion, Dr. Mitchell says that "when we consider that the pus-cells are thrown off by the million, and the minute bacillus in fewer numbers or not at all, we are forced to the conclusion that the real carrier of the disease is the pus-cell and not the bacillus."

[The foregoing would not have been deemed worthy of notice but for the deplorable fact that even yet in this day of enlightened knowledge there are still those who take it upon themselves to attempt to refute the most firmly established truths of exact scientific investigation, and thereby, either from a pitiable ignorance or a bigoted prejudice, promulgate theories which, though utterably untenable, may serve to do harm. Of such a character we believe to be the series of illogical conclusions deduced by Dr. Mitchell in his feeble attempt to deny the the etiological rôle of the bacillus of Koch in pulmonary tuberculosis. In only one point is he not justly liable to criticism, viz.—that the clinical course of tuberculous disease of the lungs does not stand in relation to the demonstration of the specific germ in

the sputa, nor when present to the number of bacilli enumerated. This no one will care to deny, for it is a fact long since established. However, by what system of logic Dr. Mitchell reaches the conclusion that because not always present in the sputa the germ is not to be looked upon as the causal agent in the production of the disease, is hopelessly beyond our powers of comprehension. Neither can we appreciate the delicate distinction which suggested the substitution of *Ulcerative disease of the lungs*, for *tuberculosis.*

In this connection it might be well to recall the fact that the term *tubercle* has been employed as descriptive of the characteristic anatomical lesions peculiar to this disease ever since the time of Sylvius, and that Koch's bacillus derived its name therefrom and that the affection was not named for the bacillus. Again *Ulcerative disease of the lungs*, can scarcely be considered as applicable inasmuch as ulceration is by no means a process incidental to tuberculosis alone and neither is tuberculosis an affection primarily ulcerative in character. A moment's consideration of the special pathology will make it perfectly clear that especially in the beginning, and in many instances throughout the entire course of the disease we are dealing with closed foci of tuberculous infiltration from which the escape of the germ and its presence in the sputa is manifestly an impossibility. Only when destructive processes, leading to caseation, softening and liquefaction have been induced, and not before, do we expect to find tubercle bacilli in the sputum. That in a given case they are not demonstrable, can not be accepted as evidence of the absence of tuberculous involvement, and in failing to appreciate this point, Dr. Mitchell made a most faulty deduction.

Now because in specimens of sputa he found that tubercle bacilli were not as numerous as pus-cells, or that pus-cells were present and bacilli absent, he jumped at the conclusion, perhaps by intuition, that the pus-cell was the carrier of the special toxic principle of this disease, and that it, and not the bacillus, was the exciting cause, at the same time questioning the rôle of the latter on account of its minute size.

Had the author even an elementary conception of the pathology of inflammation, he would see in the pus-cell nothing but a leucocyte, and were he conversant with the fundamental principles of bacteriologic science and the relation of microörganisms to disease he could not possibly maintain the opinion that because small the bacillus in question can not be the etiological factor in the production of tuberculosis.—Ed.]

EXPERIMENTAL PULMONARY PHTHISIS.

Baumgarten, *Wien. med. Wochenschr.* Nov. 2, 1901, states that heretofore it has been assumed generally that miliary tuberculosis of the lungs could be produced experimentally, but that ordinary pulmonary phthisis could not be imitated in this manner. The author goes on to say that:

"As a result of this failure to engender the last named type of disease, certain authors have even been moved to deny its bacillary origin, and to see in typical phthisis only the permanent lesions of inflammation which eventually become a breeding place for the microörganism of milary tubercle, the germ having reached the lung-tissue by inhalation.

"Such a hypothesis can not be proved on anatomo-pathological grounds, but it is very difficult to disprove it; for the inception of pulmonary phthisis in mankind is seldom seen in autopsy, and the few cases which come under observation by chance, exhibit such complication with older inflammatory lesions that no decision can be reached as to which type of alteration was antecedent.

"I am not so much concerned here with the refutation of this improbable and unproved hypothesis of the origin of phthisis (which would see in the very bacillus tuberculosis only a subordinate "noso-parasite" so-called), as with the task of developing the special pathogeny along experimental lines, since it is by experiment alone that we can hope to attain to a more intimate degree of knowledge. I have made many attempts, based on the amount and virulence of the bacilli in cultures, to obtain a medium of inoculation which could communicate pulmonary phthisis; but for a long period my efforts were unsuccessful. In ordinary inoculation-tuberculosis, it is not such a rare thing to find small cavities within the caseous conglomerations of tubercles; and the longer the animals live the more likely are we to find these formations. In the experiments of Troje and Tangl with artificially weakened tubercle bacilli, larger cavities were produced in the lungs. But aside from the fact that all the cavities thus far produced have been relatively small, the typical locality—viz. the apex, from which the rest of the lung is infected—which characterizes clinical phthisis was entirely unrepresented in the experimental form of the disease.

"Finally, however, chance led me in the desired direction. Upon the occasion of experiments as to the mode of extension of uro-genital tuberculosis, which showed that the bacillus could infect the organism

at large through the intact mucous membrane of the urethra and bladder, I encountered for the first time pulmonary cavities in the experiment animal with the typical localization in the apex. My attention once drawn to the possibility of this occurrence, I have prosecuted my researches along these same lines, and with such success that I am now in a position to engender a disease in animals which in every way corresponds to pulmonary phthisis in mankind. In order to obtain positive results it is necessary to use bacilli of full virulence and in not too large amount, and to employ them in the manner already outlined.

"I take the liberty of showing you a specimen, from one of my most satisfactory observations, which illustrates in typical fashion this experimental pulmonary phthisis. Here we see a cavity which takes in almost an entire upper lobe and is lined with a continuous cheesy deposit in which occur tubercle bacilli in abundance in pure culture. This huge cavity like all others which I have produced, has been formed solely by tubercle bacilli, which have received no assistance of any sort from other microörganisms, accidentally present. Extending downwards from the cavity we find larger or smaller tuberculous foci, the finest and more recent of which are seated in the base of the lung. In the opposite lung no cavity has formed as yet, although there is a large cheesy focus in the apex. Had the animal lived longer this focus must have become a cavity. The same tendency of the infection of the lung from the apex downward may also be seen in this side of the body.

"If we now ask for an explanation of the production of this phase of tuberculous infection, my own opinion would place the greatest stress upon the probability that but few of the bacilli which penetrate the stratified epithelium of the bladder are actually deposited in the apex of the lung, in which locality they arrive in slow succession; only by a gradual and individual importation could a preference be shown for a single locality of the body like a pulmonary apex; had the bacilli been injected in bulk within a vein, the entire lungs would suddenly have become permeated with the nodules of miliary tuberculosis. When the bacilli are introduced subcutaneously or within the eyeball, the explosion of the disease in the lung is much less violent and extensive. In any case, the lungs show a predilection for the disease. In metastatic miliary tuberculosis, the apex of the lung invariably shows more of a tendency to infection than the lower lobes, and in the first named locality we see large lesions with a greater tendency to confluence.

"In miliary tuberculosis in mankind the marked tendency to

attack the apex has often been noted, as Ribbert originally claimed. This preference may not be so apparent in the advanced stages of the disease, for by this time the remainder of the lung has become permeated with the tubercles. The predilection of human tuberculosis for the apex has heretofore been ascribed chiefly to the defective ventilation of the upper lobes in the act of respiration; so that inhaled bacteria came to be retained within the apices. This predilection constitutes the chief support of the inhalation theory.

"In our experiments, however, the bacilli reached the apex not by inhalation, but through the blood, yet the predilection was none the less apparent. It is therefore no longer justifiable to explain this localization by the inhalation of a specific bacillus. If it may be regarded as proven that the apex is the most poorly ventilated portion of the lung, the blood circulation in this locality must profit least of all from the mobilization which follows the inspiratory act. We can therefore comprehend that the retardation of the apical circulation must favor the adhesion of bacilli to the pulmonary capillaries.

"The longer one investigates, the more one compares the various pictures of human tuberculosis as seen in the autopsy, the more does one become convinced that sharp lines of demarcation between the three chief types of pulmonary tuberculosis do not exist; and that acute miliary tuberculosis, phthisis florida (acute caseous pneumonia) and chronic ulcerative tuberculosis (ordinary consumption) shade into one another by transitional gradations into common ulceration tuberculosis; so that there is a great temptation to regard the latter as of haematogenous origin.

"This view can only be corroborated by the weakness of the evidence adduced in support of the inhalation-theory; for there is not a single recorded case in which such an origin of pulmonary phthisis has been proven beyond doubt. It is self evident, however, that the possibility of infection through inhalation of bacilli is not disputed; but the prevalent view that this method is the chief—practically the sole—method of the propagation of phthisis must be designated as unproven and very doubtful.

"Recently Aufrecht in his well known essay, *Die Ursache und der örtliche Beginn der Lungenschwindsucht*, (Vienna, Holder, 1900), represents the view that pulmonary consumption no less than acute miliary tuberculosis is of haematogenous origin, and due to the penetration of the bacilli into the blood-stream with ultimate deposition in the walls of the blood-vessels of the lungs. If I do not deem Aufrecht's proof sufficient to uphold his views, and do not agree with

him in regard to the histological processes which underly pulmonary phthisis, I nevertheless look upon his criticism of the inhalation-theory as of value; since it constitutes testimony from an independent source, supported by clinical and anatomo-pathological evidence, to the effect that the inhalation-theory is based upon defective data.

"Ribbert has also expressed himself recently in favor of the haematogenous origin of human phthisis. It is true that he still adheres to the inhalation-theory, but holds that the bacillus is not inhaled within the lungs. The microörganism, from his point of view is absorbed through the intact mucous membrane and thus reaches the bronchial lymph-nodes. From these structures it makes its way to the blood and thence to the lungs. If I am unable to follow Ribbert in his theory of the 'aerogenous' infection of the bronchial glands, and of the haematogenous infection of the lungs from this primary bronchial tuberculosis, I am nevertheless pleased with the point made that ordinary phthisis may occur through haematogenous bacillary infection; and that such an etiology is far more frequent than that of direct aërogenous infection."

[That Baumgarten's experiments have shown that tubercle bacilli may penetrate the mucosa of the bladder and urethra, without leaving a lesion at the point of entry, and that haematogenous infection of the lung may supervene, with the development of a typical form of tuberculosis in the apex, we do not doubt.

Evidently the author's results demonstrate the occurrence of haematogenous infection, but we do not believe that they furnish sufficient grounds for his opposition to the inhalation-theory, except in so far as a direct infection, by inhalation, of the bronchioles and air vesicles is concerned, and this we have long since held to be prevented by the intricate ramification of the smaller tubes and by the constant presence of residual air in the lung. We must, however, still remain of the opinion that germs may be carried directly into the larger bronchi by the force of the inspiratory air-current.

That the apex is commonly very early involved we all know and that this is due to mechanical causes which render the circulation less active in this region is the most plausible theory so far advanced as explanatory of this fact. Baumgarten believes the apex to be the seat of predilection in haematogenous infection, when but a limited number of germs gain entrance to the circulation at a given time, whereas the disseminated form of tuberculosis is dependent upon the introduction into the blood of numerically larger quantities of bacilli. Whatever mechanical cause we may attribute as accounting for the peculiar ten-

dency of the apex to early involvement in phthisis, this must remain a constant factor, while the number of germs which gain access to the circulation at a given time must be variable. Therefore it seems not illogical to conclude that the location of the primary port of entry—be this situated in the bladder, intestine, a bronchus, or elsewhere—would in no way influence the result. We would therefore assume that inhalation of virulent tubercle bacilli might readily lead to the establishment of haematogenous phthisis of the apex, with or without primary lesion of the bronchial mucous membrane, the germs entering the circulation directly through the bronchial wall or indirectly from a primarily-involved bronchial lymph-node.

Baumgarten states that no case of inhalation-tuberculosis has ever been proven beyond a doubt. In our opinion the results of the investigations of Koch, Tappenier, Cornet and others with animals, and the observations of Birch Hirschfeld in regard to the seat of the primary lesion of phthisis, should tend to effectually negate such a statement.

In 1898, Cornet demonstrated before the Medical Society of Berlin, 48 animals, 46 of which had become tuberculous from inhalation of powdered sputum, the latter having been placed upon a rug upon which the animals were kept for several days. It seems to us far more reasonable to accept the inhalation-theory in this connection, than to suppose that the infection occurred through the mucosa of the genito-urinary apparatus, or in still some other manner.

In 30 or more cases in which death resulted from accident or from acute disease, Hirschfeld found tuberculous lesions of the bronchi which he held to be primary. These people had been in sufficiently robust health to check the infection, by reason of their excellent vitality, before it could lead to secondary foci, and therefore the lesions found were of the variety known as chance discoveries. It had taken him many years to collect this material. In a small proportion of cases, the initial lesion was in the interstitial tissue and these instances he attributed to haematogenous infection. In the great majority, however, tuberculous ulcers of the wall of a branch of the "posterior apical bronchus" were demonstrated usually at the point of ramification into smaller bronchi, whereas the lung parenchyma itself, remained intact. Hirschfeld believed that he had shown beyond a doubt that the primary lesion of phthisis occurs in the wall of a medium sized bronchus. Undoubtedly he succeeded in making out an exceedingly strong case in support of the inhalation-theory, and in our opinion, the latter must still be held accountable for the majority of the cases of phthisis. Editor.]

MODES OF PROPAGATION OF PHTHISIS AND HOW TO ANTAGONIZE THEM.

Flügge, *Zeitschrift für Hygiene und Infectionskrankheiten*, Aug. 27, 1901, has recently made some new experiments which are a continuation of those reported by him two years ago. At that time he showed that dried sputum may be infectious under certain circumstances, but that a more nearly universal source of danger was to be found in the particles of infected spray projected by the consumptive in the acts of coughing, speaking, etc. Since the earlier report Flügge's results have been confirmed by independent workers.

As we have no means of knowing the proportion of cases infected by dried sputum, spray, etc., the author has made some fresh experiments to throw some light on this aspect of the propagation of the disease. Cornet's dust experiment occurred under circumstances in which natural conditions were greatly exaggerated. He further made no distinction between dust which falls to the ground and dust which remains suspended in the air.

The author made use of a glass cabinet for the dust to collect in, and employed Cornet's process of beating a carpet infected with dried sputum. The result appeared to show that the dust which falls is coarse and heavy and very shortly becomes innocuous. The dust which floats in the air, however, remains virulent for a half-hour or even an hour. The fibres of an infected handkerchief which has been rubbed, torn, etc., float in the air for a long period. This experiment was simply intended to illustrate the two kinds of dust, as the conditions were exaggerated over those of real life.

The author found that the air of a phthisical patient's room examined at different periods, was not often infectious. The floating dust, to be dangerous, must be present in clouds, as during the act of sweeping, and in manufactories where dust is constantly in the air. These are the conditions where dried sputum, suspended in the air, is a menace to health.

When now is the greatest danger from infected spray? How much of this spray settles and how much remains to be breathed? A patient was placed in a closed cabinet and allowed to cough for a certain period, and the air of the cabinet was examined from time to time. The conclusion reached was that the air continues to hold contagious particles for a long period, although the latter doubtless tend to precipitate to a large extent.

Other experiments were made to determine the tenacity of life

in bacilli coughed out in spray form. It was ascertained that the germs do not maintain their vitality for more than 4 or 5 days.

An objection to the doctrine of the infectiousness of dust and spray lies in the absence of proof that the germs therein contained reach the bronchi. This problem has been studied on animals, which have been allowed to inspire a spray of the bacillus prodigiosus. The animals having been killed and dissected within half an hour, cultures made from various portions of the lungs have shown that the bacillus must have penetrated into the finest bronchioles.

If the animals were not killed for several hours, however, such cultures could not be obtained. It is not known whether the disappearance of the bacilli was due to their death or to absorption.

This latter class of experiments instituted by Nenninger, shows us the possibility of auto-infection of the consumptive. Thus he may infect his neighborhood with spray which he later rebreathes and perhaps thereby infects new areas of the lungs.

Those who live in intimate relations with consumptives must necessarily run a considerable risk of infection from the spray. The dried sputum is chiefly a source of danger where untidiness prevails. It is not necessary for the patient to spit upon the floor, for a handkerchief soiled with dried sputum is equally a source of danger in various ways, as are other articles of wearing apparel or bedding similarly contaminated.

In regard to the important problem of disinfecting soiled articles, Steinitz has recently tested the efficacy of the disinfectants in common use. Most of the latter act only in high concentration and by prolonged exposure. The best he found to be sublimate (5-1000).

Better than attempts at chemical disinfection is the use of destructible spit-cups, which may be burned, or of vessels sterilized by boiling. If handkerchiefs are to be used for expectoration they should be made of paper and destroyed after short use.

Soiled handkerchiefs come in contact with the pockets and with other soiled clothing. Such articles should be subjected from time to time, to formalin-disinfection, as a general precautionary measure.

Formaldehyde vapor is the best disinfectant for rooms, furniture, etc. When a patient cannot be induced to carry out these principles and becomes a source of danger to those about him, isolation is the only rational course to pursue.

ON THE DISPOSAL AND DISINFECTION OF TUBERCULOUS SPUTUM.

Steinitz, *Zeitschrift für Hygiene und Infectionskrankheiten*, Bd. XXXVIII, No. 1, states that our precautions thus far in the disposal of tuberculous sputum consist principally of conveying it into the waste pipes of the house after rinsing the vessels which contain it, with or without previous application of chemical or thermic disinfection. Research has taught us that tubercle bacilli when mixed with sewage do not perish for several weeks. Recently Musehold has shown that these germs were alive 194 days after their introduction into drain-water. Facts of this sort teach us that we should destroy these bacilli before committing them to sewers, etc. It is advisable for cuspidors to be treated with disinfectants which must have the qualities of harmlessness, low cost and freedom from odor, and which, moreover, must promptly destroy the germs.

Schill and Fischer have tested many disinfectants on tuberculous sputum and have found that 5 per cent. carbolic acid is not fatal until 24 hours when the amounts of sputum and disinfecting solution are the same. Sublimate, 2 parts to 1000 was not fatal at the end of 24 hours. Gerlach instituted comparative tests with carbolic acid, lysol and creolin of 5 per cent. strength each. He found that the lysol solution was fatal in 3 hours without previous agitation, while the other two substances proved themselves ineffectual even after 24 hours. Spengler used 10 per cent. solutions of aseptol, creolin, carbolic acid and lysol, mixing them with equal parts of sputum without agitation. He found that the lysol solution was efficacious in 12 hours, while the others were inoperative at 24 hours. These two authors with others have insisted that lysol should be our dependence in the destruction of the bacillus. But lysol is a comparatively expensive substance.

Other disinfectants have been tested in this connection. Traugott employed solutions of iodine trichloride, (1-10 per cent. and 1 per cent.) making a thorough emulsion of the sputum. In one hour's time all germs had been destroyed.

Aniline vapor and absolute alcohol are too expensive for disinfection. Generally speaking we have no ideal chemical disinfectant, and many authorities prefer to renounce the notion of chemicals in connection with the problem of rendering sputum harmless.

Thermic disinfection comprises the use of live steam, boiling, and burning outright. Schill and Fisher found that boiling killed the bacilli in 30 minutes while live steam accomplished the same result in 15 minutes. Grancher and de Gennes found the steam vastly

superior to the chemical sulphate of copper, carbolic acid, potash and sublimate. Various patterns of apparatus for exhibiting the steam have been devised and that of Kirchner has proved of value in hospitals. But these contrivances are too expensive for the poorer class of patients.

Boiling the contaminated vessels is by no means readily carried out. In the first place a certain result is obtainable only after half an hour, while the shape and size of the vessel are not readily adapted to this form of sterilization. Destruction by burning is simple and efficacious if the vessels to be destroyed are only combustible. Prausnitz proposes that consumptives should expectorate into wood wool, while others have suggested the use of receptacles of papier-maché. Cornet objects that unless care is used with these receptacles the heat might volatilize the infectious sputum. This fear seems to be without foundation.

Sputum prophylaxis has a much wider application than the disinfection of cuspidors, for in addition to the gross masses of expectorated material we have to destroy that portion which soils the handkerchiefs and which is carried from the latter to the pockets, etc. Further the sputum which remains in the patient's mouth is projected into the air of the room in the form of fine spray when the patient talks, coughs, sneezes, etc. It is hardly practicable to destroy by combustion every domestic article which comes in contact with the sputum.

Schill and Fischer made numerous experiments with dried sputum, and regard the latter as much more difficult to dispose of than is fresh expectoration, but Jaeger found that 5 per cent. carbolic acid will destroy the bacilli in dried sputum in 5 minutes. Delepine and Ransome warmly recommend 10 per cent. solution of chloride of lime, it being necessary only to dip the contaminated clothing, etc., into this solution and then to brush it.

For the disinfection of dwellings and furniture the agents most highly commended are lysol, chloride of lime and sublimate (3-1000). Formalin in solution appears to be inferior to the foregoing, but has not been tested systematically. There is no doubt that formaldehyde vapor is able to destroy the bacilli in dried sputum.

The author now details his personal experiments, first with fresh sputum. He began with iodine trichloride, using various strengths (1 per cent., 1-2 per cent., 1-10 per cent., 1-20 per cent., etc.). After treating balls of sputum moderately rich in bacilli with these solutions he proceeded to inoculate animals with the sputum thus treated. He found that animals subjected to the 1 per cent. strength did not

become tuberculous, but that in the other cases the disinfection was incomplete. This 1 per cent. solution required over 3 hours to kill the bacilli, and in general the chemical did not give uniform results—thus the 1 per cent. solution was sometimes less effective than the 1-4 per cent. solution.

The author next took up formalin, using it in various concentrations. The 40 per cent. formaldehyde known as formalin was used in the strength of 10 per cent. and 2-5 per cent. After the sputum had been treated with the formalin the animal experiment was repeated. As all the animals became tuberculous the inference was that formalin even in considerable concentration was unable to disinfect ordinary sputum after due exposure.

Copper sulphate likewise proved inefficacious. Hydrochloric acid was now tried, the commercial 25 per cent. strength being used in 4 per cent., 2 per cent., etc., concentration. Sputum treated with this chemical was found to be virulent to animals and therefore the acid was rejected from the competition in weak solutions. But in a strength of 15 per cent., 12 per cent. and 9 per cent. the results were positive. Generally speaking to be effective the acid must be used in high degrees of concentration or if in weaker solutions it must be applied when hot.

Hydrochloric acid was also used in alcohol, and some of the results were positive, others negative.

With sublimate, it was found that a 5 to 1000 strength destroyed bacilli in sputum in 1½ hours; a 2 to 1000 solution required from 3 to 5 hours, and a 1 to 1000 solution 6 to 8 hours.

Comparative tests with infected handkerchiefs showed that sublimate was superior as a germicide to formalin or iodine trichloride.

Dried sputum on the floors, etc., of dwellings could be readily disinfected by formaldehyde vapor, after a variable number of hours. Many experiments, however, resulted negatively.

After detailing further experiments along the same lines the author sums up as follows:—The fresh sputum must be received either in combustible cuspidors, etc., or in spit-cups which can be disinfected by boiling, or in handkerchiefs which may be boiled or soaked in 1-1000 sublimate solution for 5 hours, or in paper napkins which may be burned. The habitations and clothing of phthisical individuals may be disinfected as follows; when the floor is soiled with sputum the latter should be treated thoroughly with sublimate solution 2 to 1000. Soiled clothing should be soaked in the same solution for 3 hours. Other room disinfection should be accomplished with formaldehyde vapor.

REGISTRATION OF TUBERCULOSIS.

Lawrence Flick, *Maryland Med. Journal,* Aug., 1901, states that the medical world is agreed:—

1. That tuberculosis is a communicable disease.

2. That, being a communicable disease, it is, theoretically at least, a preventable one.

3. That if it is a preventable disease, it ought to be prevented.

4. That for its prevention such measures as are necessary are legitimate and proper.

5. That prevention of disease is a governmental function.

6. That the arm of the government to which, in this country, prevention of disease is usually entrusted is known as a board of health.

Disputed points are:—

1. The contagiousness of tuberculosis.

2. The importance of communicability as a factor in the etiology of the disease.

3. The practicability of prevention.

4. Registration as an essential factor in a scheme of prevention.

5. The expediency of intrusting boards of health with the prevention of tuberculosis.

1. As to the contagiousness of tuberculosis, Dr. Flick states that "a contagious disease is one in which the offending matter passes from one host to another without going through an intermediary host or culture medium; an infectious disease is one in which the offending matter goes from one host to another through an intermediary host or culture medium."

In tuberculosis the contagion is transmitted directly from one host to another. In transmission direct or indirect contact is an essential factor and practically the most powerful factor. In seventy-five per cent. of all new cases of tuberculosis, transmission is brought about through family relationship, association in business or occupation, and the occupancy of quarters previously inhabited by tuberculous subjects. This has been demonstrated by Dr. Flick, as well as by others, in a topographical study of all cases with fatal issue within a given district in a given time. This is also shown in a way by the recurrence of the same number of cases year after year except as this may be interfered with by the laws of immunity and by preventative measures. Every old case is succeeded by a new one, and by practically but one, which shows that limitation and circumscription must be instrumental in bringing about such a condition. This limitation

and circumscription mean (and this is indicated by laboratory and clinical work) that the tuberculous subject is the centre from which contagion is given off and that the degree of communicability is in proportion to the proximity to that centre. The closer the contact between the actual tuberculous subject and the prospective one the more liable is transmisison to occur. Certainly an affection which is so very dependent upon contact for its perpetuation may be termed a contagious disease.

2. The importance of communicability as an etiological factor in tuberculosis is considered by many as secondary to sociological factors which predispose to the acquirement of the disease. In this connection the author emphasizes the fact that although sociological factors play an important rôle in the spread of tuberculosis, they can not produce the disease without the tubercle bacillus, while on the contrary; the tubercle bacillus can produce tuberculosis without the aid of sociological factors. "Besides," says Dr. Flick, "we cannot remedy the sociological factors but we can destroy the bacillus."

3. There are many who believe in the communicability of tuberculosis but doubt the practicability of prevention. These people argue against prophylactic measures as useless on the ground that the tubercle bacillus is given off by the millions from thousands of diseased lungs, that it is everywhere in existence and that its victims cannot be restrained. Dr. Flick points out that those who hold such views do not understand the contagion of tuberculosis and are ignorant of the life history of the tubercle bacillus.

That of all diseases tuberculosis is most easily preventable, he shows to be true, because the contagion is through chiefly but a single source, because the sputum which contains the contagious element can be disposed of, and because the bacillus once thrown off can not multiply until it enters a new host and in a short time is destroyed by the germicidal influence of air, moisture and sunlight. Thus living tubercle bacilli are not everywhere in existence, nor are they inhaled by everybody; in reality comparatively few inhale the germ in sufficient numbers to produce the disease. The author admits that the possibility exists of contracting the disease on the streets and in public conveyances and buildings, but considers this danger sufficiently remote as to demand no particular consideration. It is prolonged contact with the tuberculous subject, or prolonged occupation of quarters in which such a patient has lived which is essential to the contraction of the disease by others, and consequently, as Dr. Flick asserts, in the application of preventative measures it is necessary to consider only

the host and his environment. Disinfection of tuberculous matter immediately after its discharge renders the tuberculous subject innocuous and checks a new contagion from that source. Every instance in which prevention is successful exerts a far reaching influence in the future, since all the cases which might have resulted from this one are also prevented. Herein lies the explanation of the wonderful results which have been obtained wherever such methods have been put into operation, and in order that they may be applied to every case the first step necessary is registration.

4. In the consideration of registration as an essential factor in a scheme of prevention, Dr. Flick points out that registration is most frequently and perhaps most plausibly opposed on the ground that it is unnecessary. Those who make this objection claim that the physician in attendance is competent to see to it that such practical preventive measures are carried out without publicity. The fallacy of this proposition is best demonstrated among the poor, for the indigent consumptive does not have a physician during that period of his disease in which contagion is most intense. He is very liable to contaminate several dwellings, because he is frequently compelled to change his quarters because of inability to pay his rent. The truth of this statement is the more forcibly brought home to us if we consider that tuberculosis is largely a disease of the poor. Even if the poor consumptive could avail himself of the services of a competent physician, efficient preventive measures would not be carried out, because their successful accomplishment entails a degree of technical knowledge and diligent effort which few physicians are able and willing to give and for which there is never any compensation. Until the public is brought to the realization of the fact that prevention of disease is worth paying for, it is unreasonable to expect the physician to assume an uncompensated labor, especially when he needs the time which would necessarily be thus employed, for the earning of his living.

5. The expediency of entrusting boards of health with the prevention of tuberculosis has been questioned on the ground that they are not safely to be entrusted with the prevention of the disease. Although all boards of health are not as competent or are not organized as well as might be wished, they constitute the only legal arm of the government which has to deal with public health. If they are imperfect the remedy lies in their reform and not in neglecting the prevention of the disease. In addition to the opposition arising from conflict of opinions on the part of the profession, there are those who oppose registration because they think it brands the afflicted and

increases their afflictions. But this opposition is really based upon fancy and sentimentality, for it certainly can not work to the disadvantage of him who has the disease, if his case is reported and the proper prophylactic measures instituted. That such a patient should receive a printed document explaining to him how to prevent the spread of the disease, that he is visited perhaps by a health officer who further explains the matter to him, that possibly opportunity is afforded him to enter a sanitarium or hospital, that the house, after he has vacated it by death or removal, should be sterilized, are all measures which can certainly work no injury to him nor increase his burdens. A further objection to registration which is purely a fanciful and sentimental one is that the deaths of sensitive tuberculous subjects would be hastened by the knowledge that they have tuberculosis. In refutation of this objection Dr. Flick states that in an extended experience with such patients he knows of no single instance where the patient has derived injury from a knowledge of the nature of his affection. On the contrary the benefit which the patient has obtained from such information has gradually forced him to conclude that to conceal from a tuberculous subject the nature of his disease is in fact almost criminal. In summing up Dr. Flick says "Tuberculosis is a contagious disease, it is a preventable disease; the centre from which contagion spreads is the host; this centre is limited and circumscribed, prevention of the disease is not only practicable but easy; the keynote to prevention is control of the host, the whereabouts of the host can only be known through registration, opposition to registration is based upon false notions, fancy and sentiment; for a comprehensive scheme of prevention governmental interference is necessary, under existing circumstances governmental interference can only take place through boards of health."

[No more practical contribution to the question of registration of tuberculosis than Dr. Flick's forcible exposition of the subject has as yet come to our notice. The author's arguments are so conclusive and his deductions so logical as to be incapable of refutation. We sincerely regret that limited space prevents the reprinting of his paper in full. Ed.]

PROPHYLAXIS OF TUBERCULOSIS.

Dr. E. P. Lachapelle read a paper on this subject at the joint meeting of the Medico-Legal Society and the American Congress of

Tuberculosis, which was published in the *Medico-Legal Journal*, September, 1901.

After an appropriate consideration of the etiology of the disease both as regards the specific germ-infection and from the standpoint of hereditary as well as acquired predisposition, he points out these two important indications which must be met in order to establish a rational prophylaxis:—

1. To keep the organism from debilitation or to modify it if there already exists a predisposition to tuberculosis.

2. To prevent contagion.

To meet the first indication the author urges careful hygienic and dietetic management of children in all respects. Among the measures which he advocates are, a sufficient supply of fresh air at all times, wholesome food, moderate exercise to develop physical strength and the avoidance of muscular or nervous exhaustion and overwork.

In cases of predisposition from heredity, scrofula and rachitis the above measures should be the more carefully applied.

In adults any cause of diminished vitality should be opposed, whether this be alcoholism, bad nourishment, insufficient ventilation or anything else.

The hygiene of dwellings, boarding schools, factories, prisons, theatres, etc., should receive special oversight, particularly as regards cubic air space.

Among the practical measures to which Dr. Lachapelle directs attention as calculated for the prevention of infection the following are of importance: Notification of tuberculous cases, disinfection of places of abode of consumptives, the prohibition of dry sweeping, formal defense of spitting upon floors, pavements and in public conveyances; further, regulation of food supplies, inspection of dairies, public slaughter houses, butchers' stalls, etc.; finally the enforced teaching in schools of methods of prevention and the education of the adult public by lectures, dissemination of literature, etc.

The author expresses the belief that by these means voluntary coöperation of the masses will be secured and that the golden age of hygiene in America will be realized.

SOME SUGGESTIONS FOR THE PREVENTION OF TUBERCULOSIS.

This is the subject of a paper presented to the American Congress of Tuberculosis by Dr. C. F. Ulrich and which appears in the *Medico-Legal Journal* for June, 1901. To hereditary influence in the

acquirement of disease the author has first given his attention. He proceeds with a short discussion on digestion, assimilation and tissue building on the part of the organism, and states that so long as health prevails each organ and tissue, by a selective activity, assimilates that particular portion of the digested food which is essential to its individual function and well being, at the same time rejecting that which is inappropriate. Now the author inquires what is the result when an individual has inherited in a deficient degree this power of assimilation. In answer to this question he states that, "Substances not appropriate to the organ or tissue to be built up are deposited and form tubercles. These tubercles occupying the place of the true tissue, set up inflammation, break down, causing ulceration and suppuration. If this takes place in the intestines we have miliary tubercles, giving rise to all sorts of intestinal diseases; if in the stomach there arises a variety of lesions appropriate to that organ, among which I include all forms of gastric carcinoma. If this deficiency exists in the lungs they are filled with unhealthy deposits which interfere with natural respiration."

In such cases drugs are of no avail, fats, cod-liver oil, etc., do not accomplish the desired end. The author's observations have taught him that the only solution lies in hygenic, dietetic and general sanitary measures with the view of prevention, and he believes that the most favorable resort for those with consumptive tendency is in mountainous regions with pure air and clear, sparkling water. But of these advantages comparatively few can avail themselves. Therefore they seek to obtain the best conditions possible at home. Such is the author's position in regard to the question of prevention; he continues with the following advice on the principle of the "greatest good to the greatest number":—"In every case of confirmed tuberculosis, cease your efforts to prolong life, devoting your entire energy to the endeavor to make your patient as comfortable as possible, even though the means employed should have a tendency to shorten life." This method of procedure Dr. Ulrich urges for a number of reasons, chief of which is that "Every young, incurable victim of tuberculosis that dies before he or she has had an opportunity to bring into the world other infected beings, lessens by that death the amount of human suffering;" and further that legislative restriction of marriage in such cases can be but partially effective.

[The space at our disposal is too limited to admit of a lengthy criticism of such a contribution as the preceding. We can offer no comment as to Dr. Ulrich's conception of the pathology of the disease;

for it is so impossible that were we to consider it, we would appear to seriously question the intelligence of our readers.

Indeed his contribution would have been entirely ignored were it not for the cruelly inhuman means which the author suggests for the prevention of the spread and perpetuation of tuberculosis. Why did he not go a step farther and advocate the wholesale execution of those afflicted with the disease and a systematic slaughter of the innocent progeny of tuberculous parents? It may certainly be occasion for gratification on the part of the unfortunate victim of a preventable and in many instances curable affection, that the medical profession as a whole does not entertain the extreme views of Dr. Ulrich.—Ed.]

A NOTEWORTHY CASE OF TUBERCULOSIS OF THE TRACHEA AND SIMULTANEOUS FORMATION OF VARICES IN SITU, WITH FATAL TERMINATION.

Gideonsen, *Münch. Med. Wochen.*, Oct. 15, 1901, relates the case of a patient treated at the Falkenstein Sanatorium. She was 41 years old and had suffered with a harrassing cough and dyspnoea for a year before admission. Physicians assured her that she had neither pulmonary nor laryngeal tuberculosis. There was a further history of arthritis at the elbow joint, and this fact coupled with consumption-deaths in blood relatives caused a suspicion that the present affection was tuberculous. Expectoration was abundant but bacilli had never been found therein. The general condition was otherwise good.

The state on admission to the sanatorium was as follows: respiration forced, with slight cyanosis, prolonged expiration, abbreviated resonance over left apex, broncho-vesicular breathing in right upper lobe, a few whistling râles over both sides of the chest; enlarged terminal phalanges.

After a week in the sanatorium her temperature, which had been normal, rose suddenly to 38° C. with coincident increase in dyspnoea. She remained in bed for three weeks and upon getting up had, for the first time, a moderately severe attack of hemoptysis. She returned to her bed for four additional days as a precaution, and then got up in excellent condition, afebrile. That same evening, however, she had a profuse haemorrhage, and lived but twenty minutes afterwards, death having been of the suffocative type.

Autopsy showed pulmonary emphysema with areas of atelectasis. There were no tuberculous changes in the lungs. The trachea contained several varicose veins, while upon its posterior wall, just above

the bifurcation was a typical tuberculous ulcer of the size of a penny, in close proximity to the dilated veins. The bronchi beneath were filled with blood.

Microscopical examination of the floor of the ulcer showed tubercle of characteristic histological structure. All attempts to demonstrate the presence of bacilli in the ulcer met with failure.

It was evident that the destructive process in the trachea had encroached upon one of the dilated veins and had caused the haemorrhages, the last of which had induced death by asphyxia. The lungs having lost their elasticity as a result of the emphysema (which was due in turn to months of forced expiration necessitated by the diminished lumen of the trachea), were unequal to the task of expelling the blood from the bronchi.

This case, while extremely rare, is by no means unique. Avellis has described a similar example of fatal suffocative haemorrhage following the rupture of tracheal carices and M. Schmidt cites similar cases in his work on diseases of the upper air-passages.

Not the least striking feature about this case is the isolated character of the tuberculous lesion. Unfortunately the greater part of the cadaver was not subjected to autopsy, in accordance with the wishes of relatives; so that it is impossible to be certain that the lesion represented primary tuberculosis.

Tracheal tuberculosis is notably rare, as an independent lesion. Cornet cites but a single authentic case. Secondary tracheal tuberculosis, as a sort of variation of tuberculous laryngitis is relatively rare. Statistics show that in laryngo-tracheal tuberculosis consecutive to pulmonary consumption, some 4 per cent. of the cases have an exclusively tracheal localization.

A NEW FORM OF TUBERCULOSIS OF THE PENIS.

Sabrazes and Muratet report a case of nodular tuberculosis of the prepuce in *La Semaine Medicale*, Sept. 18, 1901. They state that we have never had any test for tuberculosis in this locality other than the microscope and animal-experiment.

Secondary tuberculosis is occasionally noted in this locality, and primary infection has followed ritual circumcision, copulation, etc.

Clinically the open ulcer is the most common type encountered, and this lesion may be likened to a tuberculous chancre, the differential diagnosis of which from syphilitic chancre, chancroid and epithelioma may be very difficult.

The literature on this subject, while once very scanty, is beginning

to accumulate, no less than three monographic studies having appeared within the past decennium.

If an adult male, between 20 and 30 years of age, develops a persistent ulcer or ulcers of the penis, having a yellowish gray, uneven surface, with but a small amount of thin discharge which dries into a shallow crust, we should think of the possibility of tuberculosis. Such ulcers are almost always multiple. Their base is infiltrated. They may develop upon the glans or inner aspect of the prepuce, and in the former locality may involve the meatus and encroach upon the calibre of the urethra. There is some inguinal adenopathy, which bears but little resemblance to the characteristic picture of enlarged glands, which accompany primary syphilis. The course of the affection is slow, and a radical cure may be effected by excision.

In some of these cases examination reveals tuberculosis of the neighboring genitals (epididymis, prostate, etc.); or perhaps of some remote visceral location. But there are cases in which we can find no other nidus of the disease, and we are then justified in regarding the lesions as primary, especially if we can find any evidence of an infectious contact.

In regard to the possibility of inoculation in situ we must consider the sexual exposure of the individual. Cohnheim was the first authority to consider the possibility of transmitting tuberculosis by sexual relations, and since his day many animal-experiments have been made with a view of learning if such transmission was possible. Miss Gorovitz has summed up what is known in this field in a thesis of recent date. It is possible to inoculate the female genital passages with the bacillus, and the disease thus inoculated is propagated by local extension and by the lymphatic route. Hence it is possible in theory for a woman with tuberculous lesions of the genitals (and secondary deposits of tubercle are not extremely rare in these localities) to infect a man through copulation. Under such circumstances inoculation of the male would be facilitated by the presence of herpes or abrasions. There is as yet no evidence of sexual transmission of genital lesions.

The occurrence of primary tuberculosis of the penis in Jewish infants as a result of inoculation incident to ritual circumcision is too well established by numerous cases to require comment. At their tender age the victims of infection are quite prone to perish from acute secondary tuberculosis of the lungs or meninges.

There is a third form of tuberculosis of the penis which may readily pass for a simple benign lesion—a sebaceous cyst possibly—

until its nature is disclosed by histological and bacteriological research. The case about to be described is unique as far as known.

The patient was a man 26 years old, who came to consultation for a complication of genito-urinary affections. Both testicles were nodular, and haematuria was also present. There was a history of pulmonary disease and scrofulous glands in childhood. The thoracic symptoms suggested implication of the tracheo-bronchial glands.

In the course of a general examination a lesion was discovered in the thickness of the prepuce. Its size and shape were those of an olive, and its appearance was that of a fibroid tumor. This nodule had first appeared two years before; and during its evolution a second nodule had formed, but had undergone suppuration, the scar being in evidence. In addition to the other unro-genital symptoms, there was a discharge of pus from the urethra, and Koch's bacillus was recognized in this discharge, as well as in the urinary sediment.

The general state of the patient was excellent, although he had some dubious evidences of apical disease, clubbed fingers and other evidences pointing to a general tuberculous disposition and evolution.

The nodule was excised and examined; its centre was caseous and contained Koch's bacillus. There could be no doubt that this lesion was of the same type as the nodules present elsewhere in the uro-genital tract.

EARLY DIAGNOSIS OF PULMONARY TUBERCULOSIS

Perkins, *Practitioner*, July, 1901, after passing in review such topics as insidious onset (dyspepsia or anaemia), acute onset (as by pneumonia), tachycardia, hyperaesthesia over the apex, the tuberculin reaction, and other conditions which pertain to the beginning of phthisis, gives special prominence to another phase of the matter not so commonly discussed. He thinks that we may often refer back to some long forgotten affection which has really been the primary lesion of the disease. How often do we see an attack of hemoptysis leave the patient in perfect health, for years perhaps; but how few of these cases ultimately escape death from phthisis. It is the rule in these primary hemoptyses for physical examination to give perfectly negative results. In the opinion of the author this experience necessarily means that a minute focus of tubercle has from its peculiar locality led to the erosion of a blood-vessel. The physician, failing to discover anything wrong is forced to believe that the blood has proceeded from the larynx or nose. It is necessary in all cases to prove that such haemorrhages come from localities other than the lungs. Such patients

must be treated as tuberculous, and with such an early start the best of results are to be anticipated.

A condition analogous to hemoptysis as a remote forerunner of phthisis is pleurisy; acute, idiopathic pleurisy occurring independently of other affections is of tuberculous nature in the vast majority of cases. This can be shown beyond doubt in serous pleurisy by the animal experiment, and is to be inferred in dry pleurisy as well. The cumulation of records teaches us that very many of these pleuritic patients have ultimately died of phthisis. These sufferers from pleurisy had better be placed at once in the tuberculous category and told of their probable condition, for they too have an excellent chance to recover.

THE DIAGNOSIS OF TUBERCULOUS DISEASE OF THE LUNGS BY MEANS OF THE ROENTGEN RAYS.

Beale and Walsham contribute a paper with the above title to the "Second Tuberculosis Number" of the *Practitioner*, July, 1901. They state that the introduction of powerful induction-coils and improved tubes has given us the means of approximate diagnosis of tuberculous affections. Many clinical observations have been made by means of the skiascope; whether in bedside observations or from recording the shadows thrown by the solid portions of the thorax and its contents, it is absolutely necessary to employ a powerful induction coil capable of yielding a 12 or 14 inch spark. The coil should be worked with two four-cell accumulators of 21 hours ampere capacity and an electromotive force of 16 volts. The anticathode of the tube should be placed directly opposite the centre of the part to be examined, and from 12 to 20 inches from the chest-wall. The rays diverge from their point of origin, hence the tube must not be placed too near the chest-wall. Skiagrams should always be taken from both the front and rear of the chest. The room must be darkened, and the eye of the operator ought to be able to discern objects in the dark. An exposure of 2 minutes is all that is required, except in the corpulent or massive, when twice that interval may be necessary. No harm can come to the skin, etc., from short exposures.

In well marked tuberculous lesions, the affected area in the lung may at once be recognized by the shadow when the lung is examined by the screen. The shadow appears larger than the area recognizable by physical diagnosis; hence the doubt that it necessarily corresponds to the deposit of tubercle.

The shadow of the bony components of the thorax is always instructive and often contradicts the naked eye picture of the chest. Thus a broad chest in the ordinary acceptation may have a weak and narrow bony thorax and vice-versa. Since the thorax and its contents are always in motion, more or less blurring of the shadows is natural.

In regard to the limits of Roentgen diagnosis in tubercle we know that the earliest deposits of the disease are not recognizable; a certain number of tubercles must be aggregated before a shadow is noticeable. It is a conservative claim that in some cases the rays are our earliest diagnostic resource. It is equally true that when a shadow is cast the disease is no longer in the initial stage. If pleurisy coëxists we see shadows only in some cases where pus is present. If the mediastinal glands are markedly involved we should see evidence to this effect in the skiagram.

The earliest shadows of tuberculous infiltration consist of faint mottling. When opacities form, caseous areas are usually present. Cavities exhibit translucency. The study of the elevation and movements of the diaphragm is of much incidental importance in arriving at a conception of the functional activity of the lung—indeed this is one of the earliest and best known results of the application of skiagraphy to pulmonary tuberculosis.

LECITHIN IN TUBERCULOSIS.

Claude and Zaky, *La Presse Medicale*, Sept. 28, 1901, refer to the animal experiments which prove beyond a doubt that lecithin is a great promoter of nutrition, and to the testimony of Lancereaux and others that this substance is of clinical value in tuberculosis, neurasthenia and diabetes.

The authors have made numerous experiments on guinea pigs, intended to demonstrate the change in weight and metabolism induced by lecithin. The animals were first inoculated with tuberculosis. The progress of the latter afféction was not arrested, but it appeared to be delayed, the animals which received lecithin, living considerably longer than the control. These lecithinized animals appeared to exhibit less waste of phosphorus, corresponding to a superior avoirdupois, during the progress of the malady.

The author next made a research into the action of lecithin in human tuberculosis. All phases of this affection were subjected to the test. Every case under treatment at the St. Antoine hospital was put under treatment, including those patients who were in the initial

stage of the malady, but it is admitted that this classification may recover under rest and regimen.

Seven of the cases treated, were in the inception of the malady, but far enough advanced for the exhibition of physical signs. The results here were of the best, appetite and strength returning. The injection of lecithin was followed, immediately by a reduction in the elimination of phosphorus; so that the drug appears to act through setting up phosphorus-retention. Increase in the coëfficient of nitrogen in the urine shows that the nutrition was improved.

Six of the cases treated, were in the second stage of phthisis, and these were mostly severe in degree, and tending to pass into the third stage.

The effects of lecithin were to promote increase of weight in those patients who had been emaciating rapidly. Naturally this feature was neither so marked or as constant as in Class A. Arrest of phosphorus waste was apparent here, as well as increased elimination of urea.

Four cases of phthisis of the third stage were included in the series. The results in these were almost negative, for in but one of the four did the weight increase. It is possible that the progressive emaciation was somewhat retarded, and it may be affirmed from the single favorable result, that lecithin can be of service in the third stage of phthisis, if the local mischief predominates over the general condition. In other words not much can be done if secondary infection is under way, with pronounced hectic fever.

No benefit accrued in two cases of acute tuberculous bronchopneumonia; but a very favorable result was obtained in a case of ordinary phthisis with very rapid evolution, the disease having been arrested in the first stage.

BOOK REVIEWS.

Entstehen und Bekampfung der Lungentuberkulose. By Dr. Paul Jacob, Berlin, and Dr. G. Pannwitz, Berlin. Vol. I., 372 Pages, Liepzig: Georg Thieme, 1901.

This volume is entirely devoted to the etiology of pulmonary tuberculosis and is by far the most comprehensive and at the same time one of the most carefully prepared contributions to this subject. Volume II which will treat on Prophylaxis and which is to appear in the near future will be based upon the evidence and conclusions from the etiological study of 3295 cases which form the basis of the present volume.

The etiological data are obtained from the histories of the aforesaid clinical cases which were at the time under treatment in 33 German sanitaria for tuberculosis, with the cooperation of their respective medical directors. The inquiries and

answers are uniform throughout, taking cognizance of everything of importance that may have contributed directly or indirectly to the acquirement of the disease from the period of infancy to its actual outbreak.

Besides the question of direct infection the subject of hereditary and acquired predisposition is most fully dealt with, and nearly 200 pages of the work are devoted to special and general analytic tables which supply an amount of ready information that cannot but be of the greatest interest to the student.

The critical analysis which follows is conservative and logical in its conclusions, showing that while the bacillus of Koch is the direct cause of tuberculosis, for its localization and for the formation of tubercles in the organism to which the germs have gained access, a certain predisposition, consisting in an heredity or acquired general debility of the whole organism or of the particular part, is essential.

Not since the reading of Prof. Cornet's work on Tuberculosis has the writer met with so interesting and satisfactory a monograph on this subject. It should be in the hands of every sanitarian and student of practical medicine.

Zur Pathologischen Anatomie des Kindlichen Alters. By Dr. A. Steffen, Stettin. 327 Pages. Wiesbaden: J. F. Bergmann, 1901.

This volume contains the pathologic findings in 234 postmortem examinations of children, 62 of the deaths having occurred from tuberculosis; the remainder were due to diphtheria, chronic hydrocephalus, diseases of the mediastinum, the thymus gland, the kidneys, brain, heart, lungs and pleura, bones and joints, etc. Critical remarks, studies and references to literature are given with each group, constituting a most valuable collection of pathologic experiences in the domain of the diseases of childhood.

The large percentage of tuberculous affections, over 25 per cent., is particularly significant, showing the prevalence of tuberculosis in children and the organs most frequently involved.

In the 48 in which pulmonary tuberculosis was present, both lungs were involved in 30, the right lung alone in 13, and the left lung alone in only 2 instances.

The right upper lobe was the seat of the disease in 40. In only 8 cases were the tracheal and bronchial glands free from the disease, and in 37 instances more or less extensive caseation of these glands was found.

Tuberculosis of the gastro-intestinal tract is recorded in 24 instances, always associated with pulmonary lesions; one case only is excepted. The mesenteric and retro-peritoneal glands were found tuberculous 35 times out of the 62 cases examined. Many other highly interesting data are presented in connection with the various diseases considered, and the student of tuberculosis will find here much which has an important bearing on the elucidation of the question of the primary seat, the extension of the disease to other organs, and more particularly the clinical course and symptoms during the life of the patient.

The importance to the clinician of such pathological studies is nowadays so fully recognized that it is not necessary to say more in comment of this contribution to the literature on the subject, except that it bears evidence of most careful preparation and of critical examination and in so far as the subject of tuberculosis is concerned, we highly commend it to our readers.

Beitrage Zur Kenntniss Der Lungentuberculose. By Dr. Ernst Meissen, Hohenhonnef. 349 pages. Wiesbaden, Germany: J. F. Bergmann, 1901.

The author is the medical director of the Sanitarium Hohenhonnef and the present work is practically a report of its activity and of the scientific and clinical experience during the ten years of its operation.

The first part deals with the location, environment, construction, and hygienic features of the institution itself, showing how well it is planned and adapted to its purposes. A full consideration of the hygienic, dietetic and general management of the disease gives evidence of much practical and painstaking observation and the succeeding sections are supplementary in scientific and clinical demonstrations of the correctness of the principles which are enumerated in the foregoing pages.

We regret, however, that in the results obtained the author thought best to deal with the cases as a whole, instead of making a classification of the stages, degree and complications of disease existing on admission, thereby giving little or no opportunity of comparing them with those of other institutions, in which difference in climate and in modes of treatment obtained.

The clinical material, after deducting cases which were under treatment for too short a time, or were still in the institution, consists of 1731 cases of pulmonary tuberculosis of which 278 or 16 per cent. reached a result that may correspond to a cure; 621 or 36 per cent. were so greatly improved that the result approached a cure, while 412 or 23.8 per cent. were sufficiently benefited as to justify the claim of being improved.

This gives a total of 66 per cent. in which the patients derived various degrees of benefit.

Specific treatment was not employed; the author's experience with the first tuberculin of Koch having been so discouraging that he has since abstained from its use.

The succeeding pages contain special contributions by Dr. Meissen and his assistants on various subjects in connection with tuberculosis, all of which are excellent, and although most of them have already appeared in current literature, they have been rewritten and conform to the present advanced thought upon their subjects.

The book as a whole impresses the reader that the scientific and clinical work are made to supplement each other as should be the case in a well conducted institution, and that the opportunities in either direction have been carefully utilized by the author.

HEMMETER. DISEASES OF THE INTESTINES. Their Special Pathology, Diagnosis and Treatment. With Sections on Anatomy and Physiology, Microscopic and Chemic Examination of the Intestinal Contents, Secretions, Faeces, and Urine. Intestinal Bacteria and Parasites; Surgery of the Intestines; Dietetics; Diseases of the Rectum, etc. By John C. Hemmeter, M. D., Philos, D., Professor in the Medical Dept. of the University of Maryland; Consultant to the University and Director of the Clinical Laboratory; etc. In two Volumes. VOLUME I—Anatomy, Physiology, Intestinal Bacteria, Methods of Diagnosis, Therapy and Materia Medica of Intestinal Diseases, Diarrhœa, Constipation, Enteralgia and Enterodynia, Meteorism, Dystrypsia, Enteritis, Colitis, Dysentery, Intestinal Ulcers, Intestinal Neoplasms, etc. With many original Illustrations, some of which are in colors. Published by P. Blakiston's Son & Co., 1012 Walnut St., Philadelphia, 1901, Large Octavo, 740 Pages. Price $5.00 per volume.

In his preface the author states that this work has been undertaken with the view of furnishing the practitioner with a complete work of American origin, from which he may readily instruct himself concerning the most approved and modern methods of diagnosis and treatment of intestinal diseases. That he has accomplished his task with credit in all respects to himself and to American medical

literature will be conceded by all who are competent to offer an opinion. Showing most extensive study, research and practical knowledge in every section, the work leaves nothing to be desired from a scientific, clinical or literary standpoint.

At first sight one might feel that so large a volume, which is to be followed by another, presumably of like size, could only be intended for the specialist, and that the general practitioner could hardly afford to enter into the study of intestinal diseases to the extent that so large and comprehensive a work implies. Such a feeling, if entertained, however, as one reads gives place quickly to one of fascinating interest. In the physiologic, pathologic and bacteriologic sections as well as in the clinical parts, the author is most complete, and neither in diagnosis nor in treatment does he leave the student in doubt, while he supports his views by ample evidence and good authorities.

Very gratifying to the student of this work will be the detailed directions as to methods of treatment, especially in regard to diet in the various diseases considered and which, in gastro-intestinal affections is the keynote to effective prophylaxis and to successful treatment. We take pleasure in quoting the author's directions for prophylactic dietetics during epidemics of cholera, typhoid fever, and dysentery, as follows:—

"Nothing raw or uncooked is permitted; nothing that has been exposed to the air; that has been much handled, or that may have come in contact with unboiled water. Every digestive disturbance is to be carefully avoided. The drinking water of the locality in question is the greatest source of danger, therefore all water which is used (whether for drinking, for cleansing the food or the dishes, for rinsing the mouth, for washing, for bathing, etc.) must be boiled for 15 minutes before use and kept in the vessel in which it was boiled, until used. Besides this, water intended for drinking or rinsing the mouth should be slightly acidulated half an hour before using by means of hydrochloric acid or citric acid: it is sufficient if the acid can just be detected. The acidulation is best done in large quantities, and the test for it is blue litmus paper which must change its color to red. If in some cases it is impossible to boil all the water, then that used for external use, as for washing, should have soft soap added to it half an hour before using. Finer soap may also be used, but its results are not certain.

Rain-water, collected under personal supervision, should be used for washing if possible; the tubs, etc., must not previously have been cleansed with ordinary water, or, if they have been thus cleansed, they must first be filled with boiling water."

The author considers as dangerous artificial soda water or seltzer, also ice, unless made from distilled water or from water of known purity.

Hemmeter does not seem to believe much in the use of mineral waters for the treatment of intestinal affections, except in chronic enteritis and colitis. The so-called herb, whey or grape cure he regards as deleterious in delaying proper methodic treatment, and in often aggravating the symptoms by monotony of the diet and by causing diarrhœa. Having never observed any himself, he says that the benefit exists in the imagination of the proprietors of the various European sanatoria in which these diets are inflicted.

The chapter on rectal feeding is likewise highly instructive. According to the author foods administered per rectum are digested probably by pancreatic ferments which pass through the bowel, by bacteria and by the succus entericus which even in the colon has an amylolytic action. Grutzner's marginal ascending motion of particles can not move the ingesta antiperistaltically; the propelling force of the

normally acting intestine is in one direction only. Antiperistalsis is a pathologic phenomenon and all the author's efforts to force the bowel to work in the wrong direction proved negative. As to the method and technique of rectal feeding nothing more can be desired, even by one who has occasion to consider the question for the first time, and if every physician were to bear in mind the eight rules laid down, rectal alimentation would not so frequently fail in accomplishing its object.

In the chapter devoted to intestinal ulceration, tuberculosis is adequately considered. While the primary intestinal ulcer is admitted to be rare in adults, the author says it is more frequent in children. As to general frequency, the author quotes Wiederhofer who found the intestine involved in 101 instances of 418 cases of children dead of tuberculosis. The small intestine was tuberculous in 98, the large intestine alone only in three cases, the large and small intestine in 22 cases. The bowel-lesion was associated with pulmonary phthisis in 76, with tuberculosis of the brain and membranes in 14, with granulation tuberculosis of the lungs in 8, with tuberculosis of the glands in 3, and with tuberculosis of the mesenteric glands in 83 cases. Among the latter were 48 cases of tuberculosis of the intestine, coexisting with that of the mesenteric glands. In about half of the cases of the intestinal and mesenteric lesions the children were less than 5 years old.

The exclusion of secondary infection from the swallowing of sputum in about 25 per cent. of these children is significant of food infection, and the absence of intestinal lesions in 35 out of 83 cases of tuberculosis of the mesenteric glands points to the otherwise established fact that tubercle bacilli can penetrate the wall of the intestine and become lodged in these glands, without leaving a lesion at the point of entry. This is of particular interest at this time when the question of infection from animal food products is so prominently before the profession.

We could easily continue our comments without finding any just cause for criticism, the author and the book-maker having each done his part exceedingly well. If we were to suggest anything at all, it would be that the reader could follow the subject more easily if the frequent references, incorporated in the text, were given at the end of the chapters or in foot notes.

BOOKS RECEIVED.

SYSTEM OF PHYSIOLOGIC THERAPEUTICS. Vol. III, 336 pages, and IV, 420 pages, on Climatology, Health Resorts, Mineral Springs. By F. Parkes Weber, M.A., M.D., F.R.C.P. (Lond.), Physician to the German Hospital, Dalston, etc., with the collaboration for America of Guy Hinsdale, A.M., M.D., Secty. American Climatological Association, Pres. Pennsylvania Society for Prevention of Tuberculosis, etc. Edited by Solomon Solis Cohen, A.M., M.D., Professor of Medicine and Therapeutics, Philadelphia Polyclinic, Lecturer, Clinical Med., Jefferson Medical College, etc. Illustrated with maps. Philadelphia: P. Blakiston's Son & Co., 1901.

EDITORIAL.

THE RELATION OF DROPLET-INFECTION TO THE PROPHYLAXIS OF TUBERCULOSIS.

The question of the danger arising from droplet-infection in tuberculosis has been the subject of extensive investigation during the past two or three years, and as a result of the facts established by various experimenters has assumed an importance which demands the careful consideration, not only of those especially interested in the prophylaxis of phthisis but of every general practitioner as well. It has been clearly demonstrated that the consumptive by coughing, sneezing, clearing the throat, talking and even by whispering, projects into the air of his vicinity many minute drops of moisture, often containing tubercle bacilli. The distance to which these droplets are projected varies, but has been shown to rarely exceed a metre, and it has been further determined that they remain floating in the air during intervals of from fifteen minutes to an hour and a half before they are precipitated. The precipitated spray soon becomes dry and remains upon the floor and furniture in the form of dust, ready at any time to again rise when the contents of the room are disturbed. The germs have proven virulent in a fair proportion of instances from two to five days after they have been given off and exceptionally, when in darkened rooms, they have retained their vitality as late as the twelfth and eighteenth day. These facts would appear significant, particularly since many of the experiments have been conducted under perfectly natural conditions which permitted of no exaggeration of those actually obtaining in every day life.

From the purely scientific data at hand it requires no very great mental calculation to make it clear to us that a single consumptive, as he moves about, might render infectious every cubic foot of air not only of one room but even of an entire house. Wherever he goes he is liable to scatter broadcast great numbers of germs which may easily find ingress, in fewer or greater numbers, into the air passages of those who share his habitation and are more or less intimately associated with him in his daily life. Surely, if the danger be so great in reality as scientific research proves it to be in theory, a question is here involved

which, in the consideration of the etiology and prophylaxis of so wide spread a disease, would be of momentous importance to the whole human race.

In this connection, therefore, we may very appropriately inquire into the relation existing between the tubercle bacilli suspended in the air in spray and the actual transmission of tuberculosis to those who are intimately associated with the consumptive.

The very large proportion of tuberculous subjects by whom infectious droplets are projected into the air by talking and even by whispering, would lead one to expect contagion to occur much more frequently and constantly than clinical experience has shown to be the case. It is a well known fact that transmission of the disease to the healthy personnel has very rarely occurred in institutions for tuberculous patients where proper measures have been taken merely for the destruction of the sputum. During a period of thirteen years although no particular precautions have been taken to guard against droplet-infection, no case of contagion has been known to have occurred in the Winyah Sanitarium. Again we are not aware that laryngologists. who must again and again have received cough-spray directly in the face while treating cases of tuberculous laryngitis, have shown a greater mortality from tuberculosis than any other class of physicians. Under such circumstances, if the danger is in reality so great, it is difficult to explain why contagion does not occur with greater frequency. Insusceptibility does not afford a logical explanation, for unfortunately not every one is insusceptible, individual predisposition and resistance being but relative, and exposures to contagion in this manner have been so numerous as to render such a theory of immunity wholly untenable.

Kitasato has proven by experiment that tubercle bacilli contained in sputum are not always virulent and capable of development, and in fact that the great majority of them are dead. This element of relative virulence of the germs coupled with the fact that many of the bacilli are actually dead when projected, is quite compatible with the experience that in animal-experimentation a considerable number of germs must usually be introduced in order that infection may prove successful. If this be true for the induction of laboratory tuberculosis, it seems not unreasonable to assume that it is also true for human

tuberculosis as acquired in the usual manner by contagion. Furthermore the living germ, after its discharge in the sputum as well as in projected droplets, does not retain its vitality indefinitely, for sunlight, direct or diffused, and changed temperature conditions sooner or later effect its destruction.

It is not our purpose to belittle the danger as it exists, but for the reasons already stated we believe that without exceeding the limits of conservatism we may look upon this danger of contagion from cough spray, etc., as less menacing than at first thought might be supposed. Still, whatever the danger may really be it is not to be ignored and every effort should be made toward the institution of efficient preventive measures. In this connection that which may perhaps first suggest itself is the wearing of a mask as proposed and devised by Fraenkel. But if the mask is to be resorted to, in order that it may be effective, it should be worn constantly, not only by day but also by night. In theory, this would be the ideal resource but that in practice the tuberculous patient would consent to the adoption of a measure so radical is hardly conceivable. At best its application would in all probability be limited to charity institutions in which the patients could be subjected to the strictest discipline.

Supposed germicidal inhalations have long been exploited as curative of the actual disease, and those who pin their faith to these would naturally seek by such means to render the germs innocuous during their outward discharge. The writer has often pointed out the inefficacy of such attempts in the rational treatment of the disease, and if further reference to the natural limitation of inhalations and inhalants in the disinfection of sputum-particle in their outward discharge is essential, it is necessary only to revert to the numerous experiments which have been made with all sorts of chemical germicides in the efforts to destroy the germs in sputum already discharged. A detailed account of the results of such experiments appears in the review of a paper by Steinitz, in another part of this Journal.

A more effective prophylaxis consists in the systematic use of antiseptic mouth-washes which, while also limited in so far as concerns any germicidal effect upon tubercle bacilli in the mouth, afford the advantage of at least mechanically cleansing the oral cavity. If

employed at frequent intervals, we may reasonably expect to diminish the number of virulent germs which would otherwise be projected in the spray; and thus we may lessen to a considerable extent the dangers arising from infectious droplets. Such a mouth-wash should be used at least three times a day, preferably before meals, and in so far as practical we should advise its employment as frequently as the cough is attended by expectoration.

An additional efficacious precaution, consists in the holding of the handkerchief before the lips during coughing, sneezing, clearing the throat, etc. Better than the handkerchief are squares of cheese-cloth which after treatment with a 5 to 10 per cent. solution of glycerine in water, will retain sufficient moisture to prevent in a measure the drying of spray-droplets. After use for a reasonable length of time before desiccation has occurred the cloth should be burned and substituted by a fresh one. Japanese paper napkins, which are still cheaper, may be used instead.

Inasmuch as all spray which is projected into the air, dries and settles as a fine dust, proper room-hygiene is a factor of prime importance in practical prophylaxis. Sweeping should not be permitted, but all dust should be removed from floors, woodwork and furniture with damp cloths. If this is carefully done the danger of contagion will be still further diminished.

Finally in order to prevent direct inhalation of projected droplets, we may suggest the maintenance of a distance of a metre or more from the patient, except at such times as necessity demands a closer approach on the part of those in attendance.

SUPPLEMENT TO THE JOURNAL OF TUBERCULOSIS.

In this part the whole subject of Pulmonary Tuberculosis will be covered by a continued series of articles written by Dr. Karl von Ruck to appear in the following order:

Article I—The Cause of Tuberculosis, and The Conditions Which Predispose to its Acquirement. Article II.—The Prevention of Tuberculosis. Article III.—The Pathology and Symptomatology of Pulmonary Tuberculosis. Article IV.—The Diagnosis of Pulmonary Tuberculosis. Article V.—The Prognosis of Pulmonary Tuberculosis. Article VI.—The Treatment of Tuberculosis, Dietetic, Hygienic and Symptomatic. Article VII.—The Climatic Treatment. Article VIII.—The Specific Treatment. Article IX.—Laryngeal Tuberculosis, its Diagnosis and Treatment. Article X.—Institutions for the Treatment of Pulmonary Tuberculosis.

THE SYMPTOMATIC TREATMENT OF TUBERCULOSIS.

THE TREATMENT OF HAEMORRHAGE.

[Continued from Vol. III, Page 111.]

Such a mental state produces circulatory disturbances, just as when from fever or from powerful emotions induced by other causes, the heart action becomes excited, irregular and weak. The respiration also grows irregular and superficial, tending to cause or to increase pulmonary congestion by which the haemorrhage may be not only maintained, but even increased.

To obviate or to diminish such a result of hemoptysis, some authors have recommended that all phthisical patients be made acquainted with the fact that they are liable to bleed from the lungs, that they be assured in advance that no serious harm will follow such an accident, and that at the same time they be given directions as to what to do in case of its occurrence.

I doubt the wisdom of such a course and also the benefit to be derived from it, and while it may be justified in individual cases these are difficult to select. My own experience has taught me that most patients who have previously suffered from hemoptysis without the occurrence of serious consequences, become as much excited and demoralized upon the advent of a new haemorrhage as they were in the first instance. They often live in constant fear of a repetition and for months thereafter are continually on the lookout for bloody expectoration. A seeming composure on the part of a patient who experiences

a haemorrhage can not always be accepted as real. This fact I have verified on numerous occasions with men who although they suppressed practically all visible evidence of excitement, and even sought to reassure their anxious relatives, betrayed their agitation and fear by marked pallor, by trembling hands, and by a small rapid pulse, symptoms which quickly disappeared upon my arrival and assurance that all would be well.

A much better plan, in my judgment, is to instruct the patient what he must do to avoid the occurrence of haemorrhage, from over-exertion, by giving minute and detailed directions in regard to rest and exercise; and incidentally we should warn him that non-compliance with directions may result in haemorrhage, stating that although not often serious, it is nevertheless to be guarded against and that haemorrhage is but rarely seen in patients who conscientiously follow advice.

Actually confronted with a pulmonary haemorrhage of a degree that does not demand immediate interference for fear of serious consequences, our first step should be to assure the patient that there is no danger, and we should justify this assurance by a perfectly calm demeanor, and by encouraging the patient to cough up the blood as fast as he feels the inclination; at the same time seeing to it, that he is in a comfortable position (partly reclining upon a couch, easy chair or bed), that he is provided with a large bowl or wash-basin in front of him, into which he can easily expectorate without changing his position more than by bending a little forward. While doing this we have time to observe the effect of our assurance, to note the pulse and heart action and consider what we shall do, if more active measures must be taken. If the patient's fear is not allayed, some more visible means for him to pin his faith to are required, and whatever this may be, it should have the advantage of being harmless. I have frequently seen a prompt result from a hypodermic injection of water, or from the administration of some reputed internal haemostatic before any therapeutic result could be expected, but a small dose of morphia with or without atropine can always be depended upon to tranquilize the patient.

If the state of circulation does not offer an indication for treatment in the manner hereafter to be considered, and we want to interfere effectually by bringing such a haemorrhage promptly to cessation, there is probably no more effective remedy than an emetic. As soon as the patient becomes nauseated, the blood pressure sinks and the haemorrhage ceases before or after the vomiting. The emetic has

also the advantage of safety and of causing simultaneous expectoration of retained clots.

It is in the treatment of such slight and moderate haemorrhages that a great number of drugs and other remedies have earned more or less repute as direct and indirect haemostatics, which is by no means justified by closer study and observation. On the contrary the whole list of internal haematostics in which I include ergot and its preparations, hydrastis, haemamalis, acetate of lead, and all other vegetable and mineral astringents, I believe to be without actual influence, and in so far as their internal administration may cause gastro-intestinal disturbances, or as in the case of ergot and lead, may act otherwise detrimentally, I consider them actually harmful. I am well aware that in thus summarily rejecting these remedies I oppose a cherished tradition, and am apparently at variance with the experience of many physicians, who from the empirical use of such remedies have witnessed times without number the desired result; just as I believed I had done in my early experience. Many years of study and the advantages of observation in several hundred haemorrhages which came under my notice in my institution and consulting practice, have, however, convinced me, that the great majority of pulmonary haemorrhages cease spontaneously and that in perhaps not more than ten per cent. of those that I have seen, was direct interference actually required. In such instances, however, the use of this class of remedies proved futile, and when after trying one or more of them in succession the haemorrhage was finally controlled, the termination appeared as likely to be due to the use of the one as the other, that had before failed, either in the same case, or in others. The only reasonable explanation, I think, is, that in such instances as in most others the cessation of bleeding was due to the diminished quantity of blood in the lungs, and to the lowered pressure consequent upon the loss of blood itself.

In the more severe forms of haemorrhage, the state of the circulation, as shown by the patient's color and pulse, and by auscultation of the heart, affords often the indication for treatment. In urgent cases the experienced physician must sufficiently comprehend the situation at a glance to guide him in his action. If the patient is pale and has a weak rapid pulse, whether because of fright or from actual loss of blood and beginning heart failure, cardiac stimulants are indicated for the relief of the passive pulmonary congestion. Particularly are cardiac stimulants to be employed if there is an accentuation of the second pulmonary sound which in well marked venous congestion of the lung is always to be noted, unless the right ventricle is also

losing its power. If the situation is not yet critical we may succeed in bringing about a better circulatory condition with digitalin and strychnine, given in full doses, hypodermically. At the same time the patient should be urged to take deep inspirations and hot applications should be made to the extremities. If digitalin or strychnine are not at hand a small dose of morphia and atropine will usually act satisfactorily, because of the primary stimulative effect.

Should conditions appear critically urgent and should the bleeding continue profusely, I would in addition to these measures, resort promptly to the ligation of the extremities, this being the quickest means by which we can relieve the overburdened heart and diminish active or passive pulmonary congestion by impeding the return of the venous blood and by storing it in the veins below the ligatures. The ligation is most effectually accomplished with elastic bands encircling the lower limbs immediately above the knee, and in urgent cases, the arms also in their middle portion, drawing the bands only tightly enough to impede the venous circulation, just as in preparation for venesection. In the absence of specially constructed bands with buckles, a common elastic bandage answers equally well; this may be improvised from elastic suspenders, or if no elastic fabric is available, an ordinary cotton bandage which can be torn from the bed-linen can be made to answer the purpose. In the cases in which I have resorted to this measure the results were very satisfactory, the bleeding growing less and the pulse improving promptly. If, however, the pulse should become smaller and more frequent, or if the patient grows faint, the constricted limbs must be partially released by loosening one or more of the bandages. When the haemorrhage is controlled the bands should be gradually removed, allowing an interval of 10 or 15 minutes after the release of each limb. Patients are likely to complain of numbness and pain in and below the constricted parts which, as well as the oedema, disappears soon after the circulation is allowed to resume its normal course.

The administration of nitro-glycerine has been warmly advocated by various authors but it is only permissible if there is still a good heart action, with well marked power of the right ventricle; when the latter has grown weak this remedy is contraindicated.

The use of digitoxin as a cardiac stimulant in this class of cases has been recommended as being most prompt and effective. I have no personal experience to offer, and have hesitated in its employment on account of its bad effect upon the digestive organs which some authors have emphasized as following its use. Sticker, however,

claims that this is due to impure preparations or unsuitable administration, and recommends beginning doses of 1-300 to 1-150 of a grain in solution of warm water, to be given by the rectum not oftener than twice in 24 hours and only for one or two days.

In another class of severe haemorrhages, the clinical picture differs from the foregoing in that the pulse is strong, the patient is flushed, or at least there is no pallor, and the haemorrhage appears to be caused by active hyperaemia which is maintained by an overexcited state of the circulation. This class requires arterial sedatives rather than stimulants, and here it is that an emetic will prove most prompt and satisfactory. If we have no urgent need of instantly moderating the flow of blood to prevent suffocation, hydrochlorate of apomorphia, hypodermically, in emetic doses of 1-10 to 1-5 gr. will lower the blood pressure and relax the arterial tone as soon as the patient becomes nauseated, and I have on several occasions seen a severe haemorrhage stop entirely before the emetic effect occurred. In the absence of apormorphia, which has the advantage of quick action because it can be given hypodermically, other emetics may take its place. In their choice ipecacuanha deserves preference because it is not irritant to the gastric mucous membrane, as are the sulphates of zinc or copper. Tartar emetic is too slow in its action. As an additional sedative to the heart, the effect of ice is reliable; it may be given internally, or an ice bag may be applied over the heart or over the supposed seat of the haemorrhage; either or both will aid in allaying the vascular excitement. Veratrum viridi has also been used successfully for this purpose.

In the presence of immediate danger ligation of the extremities should be resorted to as the first step. Before knowing the advantage of this measure I have, in one such instance, resorted to venesection, with a most prompt and satisfactory result; after the removal of about 12 ounces of blood the patient grew faint and the haemorrhage stopped.

Upon the theory that it lowers the blood pressure and reduces pulmonary congestion, atropine alone in large doses (1-50 gr. to 1-25 gr.) has of late years been highly recommended in all forms of severe pulmonary haemorrhages, but I must confess to have lacked the courage to give the doses which are claimed most effective, fearing the mental and physical excitement which they might produce and which would defeat the first step in all treatment, namely the securing of absolute mental and physical rest. In one instance a number of years ago, when I gave only 1-100 of a grain to check night sweats, the

patient grew perfectly wild and uncontrollable, springing out of bed and attempting to jump from the windows, and otherwise behaving in a manner that I would of all things avoid in the presence of haemorrhage. It took several hours before I could control this state of wild delirium, and I have ever since been extremely cautious with this drug, giving it first in 1-200 or 1-150 grain doses and feeling my way to larger ones if these proved ineffective. When combined with morphine the state of excitement is less liable to occur, but I should not exceed 1-100 of a grain for a first dose even when so combined, unless I knew something of my patient's previous toleration.

To summarize my experience I may state:—

1st. That internal haemostatics are of no value in pulmonary haemorrhage.

2nd. That slight and moderate and some severe forms of pulmonary haemorrhage cease spontaneously under rest, and the more readily, if we can remove the element of fear and excitement in the patient by a quiet and composed demeanor and by giving proper assurances as to the absence of danger. To this end the administration of some harmless remedy may, on account of its moral effect, become an aid. A small dose of morphine, with 1-100 gr. of atropine allays both the cough and the patient's excitement, and an emetic will as a rule bring the incident promptly to a close.

3rd. That in severe, profuse or long continued forms of haemorrhage, which by their degree, in loss of blood, or rapidity of its discharge, imply more or less danger, we should distinguish between the presence of active or passive pulmonary congestion by observing the state of the circulation and apply cardiac stimulants, if the heart action is weak, while sedatives should be given if there is vascular excitement; we should in either case resort to ligation of the extremities, if danger is imminent, as a means for immediate control.

4th. That if in doubt as to the use of stimulants or sedatives, the latter deserve preference, apomorphia being the best and quickest in its action; otherwise a small dose of morphia with atropine 1-100 gr. should be given hypodermically.

The treatment of haemorrhage as above described is based upon the indication to diminish passive and active congestion, and to lower the vascular pressure in the pulmonary system. To meet the further indication of favoring the formation of clot at the orifice of the bleeding vessel subcutaneous injections of a solution of gelatin have been recommended and employed with apparent success, in otherwise uncontrollable cases. In a normal salt solution (6-10 per cent.) two per cent.

of gelatin is dissolved, and three to six ounces of the solution are injected into the subcutaneous tissues. The injections are said to be painful and to be contraindicated in all structural diseases of the kidneys, in the presence of which haematuria has been observed.

With the same object in view local astringents have been used by inhalation of a spray from an atomizer. A solution of perchloride of iron in the strength of ½ to 1 per cent. is most commonly employed. While I have seen apparent success from such inhalations in instances of frequent recurrence of slight oozing under which a few mouthfuls of blood were expectorated several times during the day, I have in at least one instance seen a decided recurrence of haemorrhage caused by cough and dislodgement of clot induced by the inhalation. Inhalations are obviously impracticable during the progress of any but slight degrees of haemorrhage, and their use after the haemorrhage has ceased, in order to prevent recurrence seems of doubtful advantage, especially if the inhalation causes irritation and cough which it frequently does even in ½ per cent. solution.

The after treatment is often all that we are called upon to manage; especially is this so in private practice, where the physician has to be summoned from a distance. Unless after severe or profuse haemorrhages, we usually find the patient to be comfortable and tranquil, his mental state having improved with the cessation of the free expectoration of blood. If the haemorrhage has, however, been very copious, we may still find ourselves confronted with the serious problem of gradual suffocation from obstruction of bronchi by clotted blood. If this threatens, the patient has a livid appearance, the inspiration is short and gasping, gurgling râles are usually audible at a distance, the cough is irritable, frequent and unavailing, or there may be expectoration of bloody tinged mucus, or of small quantities of dark liquid blood. Such patients should be made to take deep inspirations and if, as usual, the pulse is small and frequent, stimulants should be administered hypodermically, brandy, whiskey, or even sulphuric ether being proper for this purpose. In a case of this kind I succeeded in causing the expectoration of the bronchial thrombus by letting the patient inhale sal ammoniac from a bottle held to his nose and mouth. The clot was expelled with a violent attack of coughing, which was followed by expectoration of more partially clotted and clear blood, after which the respiration and general condition of the patient improved promptly. Should the pulse be still of fair quality a free emetic dose of apomorphia may be tried in the hope that with the vomiting and straining the clots will be dislodged and expectorated.

Another complication of haemorrhage which may present itself is acute anaemia which may be of two forms. If, as is most frequently the case the cause is a mechanical one depending upon deficiency in bulk and quantity of blood in circulation, an attempt should always be made to augment the circulatory fluid as quickly as possible. Nature does this herself to a sufficient degree if but a moderate amount of blood has been lost, but when the patient becomes drowsy, when the face becomes pale and pinched, and the eyes recede into their sockets, and when in addition to these symptoms muscular twitching occurs, respiration grows shallow and hurried, the pulse small and fluttering, we can not hope that she will succeed in her task without artificial aid. To anticipate such a train of symptoms, after severe or profuse haemorrhage, I am in the habit of giving a warm salt water enema of about a pint, as a routine practice. Should the symptoms appear more urgent, or grow so after these measures have been adopted, subcutaneous injections of a pint to a quart of normal salt solution can usually be made, even if the exact apparatus is not at hand. In an instance that came to my notice the attending physician employed a Davidson syringe to the discharging end of which he attached his hypodermic needle and succeeded in injecting a sufficient quantity to relieve the patient; neither did he observe any abscess, although there was no time to give the syringe, which had been in use in the family, any other than rapid cleansing by the passage through it of hot water. While this may be superfluous in many cases, it is certainly a harmless procedure which may obviate the necessity of other measures for which the required instruments and apparatus may not be ready at hand. The patient's thirst is of course also satisfied, and a horizontal position advised the moment the patient begins to feel drowsy or faint, or whenever circulatory deficiency is manifested by the character of the respiration and pulse. Intravenous infusion of physiological salt solution, while simple enough in application demands absolute asepsis which would at most be available in hospitals and institutions. I have never had occasion to use it in any of the cases of pulmonary haemorrhage which I have been called upon to treat.

In instances in which repeated profuse bleeding has occurred, at short intervals during which physiological absorption of fluid has nevertheless tended to make good the bulk of blood lost, a successive haemorrhage may at once cause an acute anaemia of still more serious import which is due not so much to the diminished quantity of fluid in circulation, but to deficiency in number of the oxygen-carrying red corpuscles. In other words a state of hydraemia is induced. Saline injections are

naturally useless under such circumstances and ligation of extremities serves only to make matters worse. In these cases we are practically powerless and the only remedy is transfusion of homologous living blood. The failures reported, and the practical difficulties and the accidents incidental thereto are such that few would care to undertake it even if the means were ready at hand which, of course, they seldom are.

Fortunately there are relatively few pulmonary haemorrhages in which death occurs as an immediate consequence. In my own cases an immediately fatal termination followed in only three instances, each time from suffocation, before any effectual aid could be given. In seven the bleeding was so severe as to require ligation of the extremities. Venesection was resorted to in one, apomorphia in about ten, while in about half of the other cases a small dose of morphia with atropine was administered.

Immediate danger from the haemorrhage itself having passed, the after treatment has for its object the prevention of recurrence, the removal of retained blood clots and aspirated infectious material, and the restoration of the patient's blood state, and of the loss in weight and strength.

As to the primary object of preventing recurrence, we are most likely to be successful in cases where the haemorrhage has occurred from physical overexertion in the absence of softening and extension of destructive changes in caseous deposits, whereas the bleeding is more liable to recur when the haemorrhage appears without apparent exciting or contributing cause, especially in connection with softening and cavity formation. Recurrences are also to be anticipated when pneumonia follows the haemorrhage, during which I have frequently witnessed the daily expectoration of a few ounces of frothy, clear blood. The first essential in preventing a recurrence is rest, and this should be absolute, in bed, and should be the more rigidly enforced and the longer maintained in those cases in which experience has shown that we have reason to be on guard. In milder forms and in those in which the absence of fever justifies the assumption that softening and excavation does not stand in relation to the haemorrhage, it is my custom to keep the patient in bed until the expectoration has been entirely free from blood or bloody color for 36 hours thereafter. In others the existing fever naturally demands rest in bed, and I am sure that 10 days is not too long a period to enforce, after which we may assume that sufficient organization of the clot has occurred to prevent a recurrence of bleeding from the same vessel. For the first 36 or 48 hours especial watchfulness is necessary, the patient must be kept free from

all mental excitement, and visitors should be excluded. The diet should be light and non-stimulating, and all food and drinks given, should not be heated above 100° F. It is well to secure daily free and easy evacuation of the bowels, especially if morphia has been given to control the haemorrhage, or if opiates are used to prevent excessive cough thereafter. For this purpose Apenta, Carlsbad, or other aperient mineral waters are most useful. Straining at stool should be prohibited and enemata should be employed to aid the evacuation if necessary. The room should be kept cool, but not cold and plenty of fresh air and sunshine should be admitted.

After most haemorrhages there will be, during the first day or two, some slight expectoration of blood, or of bloody sputum at increasing intervals; whatever cough is necessary for the purpose of expectoration must not be interfered with. Only when the cough is dry or when irritation is complained of in the throat and bronchi to a degree that the patient can not resist the cough, or when it is otherwise severe or paroxysmal, should measures be taken to moderate, or if expectoration is absent to suppress it.

For this purpose I prefer heroin or codein and by the hypodermic method rather than by the mouth. If I fear that infectious material has been aspirated into the deeper portions of the lungs during the haemorrhage, I seek its discharge by the use of expectorants, giving apomorphia in doses of 1-40 gr. and increasing the doses until the secretions are materially augmented or become of more fluid consistency, without, however, causing nausea. Instead of apomorphia I have found muriate of ammonia with syrup of licorice to answer the same purpose. Although the benefit from expectorants is not susceptible to proof, I can say that I have seen fewer pneumonias since using them after severe haemorrhages, than I did before, and if the favorable reports and my own favorable experience of the action of kresatol or carbonate of guaiacol in the treatment of pneumonia is further confirmed, we may hope that their administration for the first three or four days in the cases under consideration may still further reduce the frequency of this serious sequella to haemorrhage.

In instances where the retained coagula appear to have undergone putrefactive changes, as evidenced by the fetor of the expectoration, the internal administration of rectified spirits of turpentine and the inhalation of glycozone from an atomizer have afforded satisfactory relief.

The administration of iron preparations on account of the loss of blood, and the return to a full diet, should not be undertaken hastily,

and under ordinary circumstances it is best to delay until all danger from haemorrhage is past. If then the quality of the blood is shown to be deficient by examination, peptomangan, and a more liberal dietary are in order. Many patients make up the quality and quantity of the blood in a very short time, and especially those who are free from fever and other complications, rarely show deficiency in blood count or haemoglobin per cent. as compared with previous records by the time they are allowed to gradually resume their out of door life and exercise.

With plethoric patients who have cavities, moderate haemorrhages occur at times at regular intervals; as in such individuals there is usually no active progress of the disease and but little or no expectoration, their haemorrhages are rarely attended with danger. In such cases a continued non-stimulating and somewhat restricted diet, aperient waters, with as much systematic exercise as is otherwise permissible, are indicated until through shrinking and cicatrization of the cavity walls recurrences will cease.

Internal haemorrhage has been observed in connection with softening of a caseous focus that has as yet no connection with a bronchus; the diagnosis is, however, obscured by the coëxisting lung disease, and the evidence of increased percussion dullness and dyspnoea is usually referred to other causes.

Haemorrhage into the pleural cavity occurs at times in connection with pneumothorax which may be presumed to be the case when within half an hour or an hour a liquid exudate appears in the pleural sac of the affected side. The treatment consists in the application of an ice bag over the seat of the ruptured cavity, if its location can be determined, otherwise it is symptomatic, and the haemorrhage may stop from compression of the lung, if air enters the pleural sac at the same time. Such a result has been sought in severe and repeated haemorrhages, without perforation, through intentional compression of the bleeding lung by the application of Dr. Murphy's method which consists in the introduction of nitrogen gas into the pleural sac of the affected side, and some successful cases have recently been reported.

THE TREATMENT OF PLEURISY.

Pleurisy is so frequent a complication in the course of phthisis that few patients escape altogether the experience of its symptoms, and in those in whom the lung affection progresses to an advanced stage more or less extensive pleural thickening and adhesions are present. Even in the early stages of tubercle-formation if the disease reaches the periphery of the lung, the pleura participates in the subjacent inflam-

matory processes and the patient complains of various painful sensations—often of only a dull ache or soreness which at times becomes more acute or stitch-like on deep inspiration. These pains are so frequently mistaken for myalgia or for those of muscular rheumatism, when located in the upper lobe, or for intercostal neuralgia when at a lower level, in instances in which no other marked symptoms of phthisis are manifest, that they should receive much more discriminating attention as diagnostic signs in the early stage than is usually given to them.

In the majority of instances pleurisy occurring in the course of pulmonary tuberculosis is circumscribed and of the so-called dry variety. In location it usually corresponds to a subpleural tuberculous focus or to an area of lung which is the seat of softening and impending excavation.

In certain cases in which tubercle is forming and in others in which destructive changes are occurring in the subjacent lung tissue of the upper lobe, pleurisy may supervene at this point without the experience on the part of the patient of any symptoms whatever. At the same time or soon thereafter the patient may complain of pain at a lower level, often perpendicularly below the process described as occurring in the upper lobe. The latter pleural involvement would seemingly be explained on the ground that it is secondary to the occurrence of a primary painless pleurisy above, in which the associated microörganisms have penetrated the pleura and have gravitated between the two pleural surfaces toward the base of the lung.

A more frequent complication of phthisis than pleurisy we are not called upon to treat. In the consideration of the therapeutic measures applicable it will be well to deal first with the dry forms and lastly with those in which there is effusion.

The treatment of the circumscribed dry form which is most frequently met with resolves itself largely into efforts to relieve subjective symptoms and to prevent extension. As I have stated in the chapter on the pathology and symptomatology of pleurisy (Vol. II, pg. 89) this form is not so exquisitely painful, nor is it attended by marked general symptoms as is the case at the onset of the acute exudative variety. In many instances the aching or stitch-like pain on deep breathing, coughing or change of position, is all that attracts attention, the temperature being elevated but slightly or not at all.

In such cases the external application of antiphlogistine or of counter-irritation in the form of the flaxseed and mustard poultice, together with the avoidance of all active exercise and deep breathing, is usually all that is required for relief. Even without any interfer-

ence the symptoms, as a rule, disappear in a few days. If the pain is chiefly experienced on coughing and the latter is a prominent feature the use of heroin in small doses—1-16 gr. to 1-12 gr. hypodermically, or if the cough is dry and irritating, in the form of glyco-heroin—will usually prove effective without disturbing the digestion. When the pain is very severe and always when the temperature is elevated, rest in bed is necessary, with restriction of the diet according to the degree of fever.

Again when there is very severe or excruciating pain, and the cough is frequent and aggravating in cases in which the involved area corresponds to the lower lobe, immobilization of the chest affords often complete and always partial relief. Immobility is best secured by strapping. For this purpose strips of adhesive plaster, 1½ inches wide, and cut long enough to extend half way around the thorax, are employed. Starting on the back an inch or two on the opposite side of the spine, the strip is drawn tightly around the affected side to the sternum and fastened during forced expiration. After the first is fixed in position a number of others are applied, in like manner during forced expiration, one overlapping the other successively by a quarter or half an inch. The patient should avoid all efforts at deep inspiration until all the strips are firmly placed in position.

Morphine should be employed only in severe cases when other measures have failed to afford relief.

The circumscribed dry form may, by extension and persistence in a sub-acute degree, lead to an extending chronic form which may finally involve the entire pleural sac. In this chronic, extending, dry variety there usually occurs a fibro-plastic exudate and extensive pleural thickening. While the percussion note in the circumscribed dry form remains unaltered, in this form a considerable amount of dullness results, which is especially to be detected on gentle percussion. The absorption of the exudate is an important indication, because the lung has become practically immobile and the respiratory surface which on account of the primary pulmonary disease is already impaired is still further encroached upon. In chronic dry pleurisy unaccompanied by fever, it is not absolutely essential to enforce rest in bed; the patient may be out of doors but should be kept quiet, all exercise being prohibited.

Rest in bed is, however, preferable, because arrestment of the pleural inflammation is to be the more speedily obtained the quieter the patient is kept, and because we may then have recourse to continued and prolonged counter-irritation by means of hot flaxseed poultices to

which enough mustard has been added to maintain decided redness of the skin. I prefer poulticing to blistering as well as to painting with idoine, because the effect of the former can not be continuous, too long intervals being required between applications and because from painting with iodine my results have never been decided enough to convince me that it really accomplished any good.

Acute forms of pleurisy with serous or sero-fibrinous effusion, which usually begin with considerable fever and sometimes with a chill, may occur abruptly or may follow immediately upon the occurrence of the dry circumscribed variety. In a very few instances I have seen an acute inflammation, followed by abundant serous effusion, occur suddenly in the course of a chronic extending fibro-plastic pleurisy. The pain, in the acute forms with effusion, may often be controlled by counter-irritation. When this form makes its appearance abruptly there is at the beginning no effusion yet formed, and in this stage strapping may be resorted to, in order to diminish or remove the pain. But if the chest be strapped great watchfulness must be exercised to detect the effusion which is likely to appear in the course of a few days. As soon as fluid is present in the pleural sac the pain ceases and the straps which are now no longer necessary for its relief must at once be removed to permit full expansion of the chest wall and to prevent more extensive compression of the lung itself. Of course from the onset the patient should be kept absolutely and unconditionally at rest; this is the most important essential in the treatment of acute pleurisy with effusion. Cough must be allayed by heroin, codeine or even morphine, the choice being in the order named, but only when required on account of severe pain. I have also employed papine, which has given me very satisfactory results and which possesses the very desirable advantage of not causing constipation.

The fever needs no interference unless it reaches 103° or 104° when fractional doses of thermol or phenacetin may be given—1 gr. to 2 gr. every two or three hours until the fever begins to decline, when less frquently repeated doses suffice. The employment of the coal-tar antipyretics is indicated only when the degree of fever is excessive, and this is usually the case for the first two or three days only. They should not be administered over long continued periods under any circumstances, and of course the condition of the heart as well as that of the patient in general must be taken into consideration. Applications of cold water to overcome the pyrexia are most undesirable. In fact by causing deep inspirations they not only aggravate the painful symptoms but tend to delay recovery. In the cases which I have treated

I feel quite sure that hot flaxseed and mustard poultices have been beneficial; they certainly make the patient much more comfortable and tend to promote the absorption of the exudate.

Internal remedies such as diaphoretics, diuretics and iodine employed with the view of hastening absorption of the effusion I have discarded years ago. Whatever their merit may be in the treatment of pleurisy other than that which complicates the course of phthisis, in the latter their prolonged use generally does harm by interfering with the appetite and digestion.

If after the third week the effusion has not diminished, aspiration is advisable although there may be no urgent symptoms. My experience has been that by aspiration the duration of the affection is materially shortened and what is of much greater importance the final result as to the subsequent functional activity of the lung is much better. An expectant course is unsatisfactory because absorption is often a very tedious process, because there is apt to remain much more fibro-plastic residue and because the lung is decidedly more liable to remain permanently crippled than when aspiration is early resorted to.

Purulent exudates require surgical measures which it is not my purpose here to discuss. However, I wish to record a very exceptional experience with two cases in which I removed by aspiration 800 c. c. and 1100 c. c. respectively, of a purulent effusion, expecting to resect and drain later. Resections proved unnecessary as these patients made good recoveries without further interference.

The after treatment of exudative pleurisy with a view of restoring to functional activity the more or less crippled lung is of very great importance; this may be instituted when the fever has subsided, after the effusion has been removed or has been absorbed, and when pain has permanently disappeared upon as deep inspiratory efforts as the patient can make, and finally if no contraindications exist. The expansion of the compressed and retracted lung and the final restoration of its functional activity is best promoted by the systematic use of the pneumatic cabinet which at the same time prevents the organization and contraction of adhesions. Care must, however, be exercised not to apply too much pressure in the beginning; my rule is to start with a differential pressure of only one inch on the water scale, to maintain this for a week and then to increase very gradually. Upon the occurrence of the slightest pain, the sitting should be stopped, and should not be repeated until after a few days' intermission. At first the sittings should not last over five minutes, but they may be lengthened to ten minutes in the course of a month. With these precautions I have never

observed an exacerbation of the pleurisy. In the absence of the pneumatic cabinet systematic breathing exercises should be employed, but they should be strictly prescribed and limited. Denison's in-and exhaler will be found very useful for this purpose.

THE TREATMENT OF PNEUMONIA COMPLICATING PHTHISIS.

Intercurrent pneumonic inflammation is a much more frequent complication in the course of pulmonary tuberculosis than is apparently conceded.

In many instances it initiates the phthisical stage, developing upon a latent tuberculous deposit in the course of acute bronchitis and especially in that of influenza. In the section on pathology and symptomatology I have referred to this subject at some length; here I may add that apart from inflammation of the lungs, incidental to influenza, etc., in the course of phthisis, pneumonia is caused most frequently by aspiration of sputum during coughing, and by its gravitation during sleep. The pneumonias which follow haemorrhage and constitute so unfavorable a sequella of its occurrence are produced in like manner, the liquid blood acting as the vehicle, which, more or less mixed with the sputum, is aspirated into the smaller bronchi.

The pneumonic area is often confined to but a few lobules, when its diagnosis by physical examination may be very difficult, or even impossible; in not a few instances, however, considerable lung portions become involved, and several foci may exist in one or in both lungs. In other cases pneumonic areas occur in the peripheral tissue of recently formed cavities, and this is undoubtedly due to penetration of the cavity walls and invasion of the adjacent lung by pathogenic microörganisms.

The diagnosis is always greatly facilitated by a carefully kept temperature record, since the pneumonic complication is attended by a continued form of fever for at least the first few days. The fever which may have previously been absent or has pursued a hectic type, rises abruptly, perhaps with a distinct chill, or with chilly sensations and reaches 102° F. or over on the first day. The temperature does not return to the normal or subnormal on the following morning although the fever remits, just as it does in pneumonias of a catarrhal type, apart from phthisis, the degree and duration of the fever depending upon the amount of the lung involved and extension to adjacent lobules. In the pneumonias complicating tuberculosis, we do not often observe the recrudesences which occur in the course of acute capillary bronchitis, because new areas become involved only after the aspiration of new infectious secretions, which does not happen frequently in the

same patient. We therefore find that the fever moderates as a rule, on the second or third day and that it usually subsides in the course of a week. If we can exclude acute, exudative pleurisy which is generally not difficult, such intercurrent continued fever in the course of phthisis will be found to be due to pneumonia in almost all instances, and if reliable records exist as to the previous auscultatory and percussion findings, painstaking and repeated examinations of the chest will, as a rule, confirm this view.

The treatment of such pneumonias deserves the greatest attention because its success or failure will markedly influence the future course of the patient's illness. Absolute rest in bed is to be enjoined. Moist heat, with or without counter-irritation, should be applied over the pneumonic area in the form of mustard and flaxseed poultices, or of antiphlogistine.

If the fever is very high and prevents sleep, and if the heart furnishes no contraindication, fractional doses of thermol or of pyramidon can be used with advantage for the first and second day, when the fever naturally declines. Until several years ago, I had much faith in the administration of one or two full doses of quinine (10 to 15 gr.) and while I still believe its use to be valuable, I have for the present abandoned it in favor of full doses of kresotal which has appeared to have a decided influence in diminishing the ordinary duration and in bringing about resolution of the pneumonic process. My experience extends now over upward of 20 cases, in none of which the pneumonic area progressed to caseation as is so apt to be the case in pneumonias complicating pulmonary tuberculosis, especially if the inflammatory area is already the seat of tubercle. This may be of course, a fortunate coincidence, and I would still consider it so were it not for the favorable results reported by various clinical writers, in other forms of pneumonic inflammation.

In patients already exhausted by reason of the advanced stage of their pulmonary phthisis (and they represent the greater number in which these pneumonias occur) the use of stimulants, strychnine 1-30 to 1-10 gr. three times a day, and of alcoholics, or of both is often necessary. The patient's nutrition should have especial attention, and recourse should be had promptly to rectal feeding if the amount of food taken by the stomach appears inadequate.

[TO BE CONTINUED.]

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ORIGINAL CONTRIBUTIONS.

LIGHT—ITS THERAPEUTIC IMPORTANCE IN TUBERCULOSIS AS FOUNDED UPON SCIENTIFIC RESEARCHES.

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It is a trite saying that "There is nothing new under the sun!" Like many other familiar phrases, this is frequently uttered without any real perception of its scope. *Nothing new*, indeed, and yet the world moves ever onward! Then what is progress, or is there anything or any idea to which the word *progress* may be applied? Every now and then the world is electrified by some new idea, or some new discovery! Then, lo! some delver in ancient lore, some seeker in forgotten mines shows that the new idea is even old, perhaps the new discovery nearly as old as the world itself. Facts are ascertained, demonstrated, taught, learned and——forgotten. Theories, vague and uncertain, even in the minds of their weavers, are accepted for science! Then, lo! the old forgotten facts spring again into view and the theories flee, to be forgotten in their turn, only with this difference, that there is no resurrection for them!

It is not very many generations since the world knew nothing of the solar system, its marvelous revolutions and the laws that govern its sun, moon, stars and planets. Sir Isaac Newton made some astounding discoveries, and there was doubt, astonishment, consternation. The world was not unwilling, but unable to believe. To-day, men look back and wonder how any one ever believed otherwise than in accord with the now accepted science of astronomy which has acquired a countless number of facts since Newton assigned to our sun its rightful

place and authority in the system of astronomy that is almost an exact science.

Since Newton's day, it has been ascertained that many centuries before, even in the sixth century before the era of the "Sun of Righteousness," the famous Ionian philosopher, Anaximander, the first systematic writer on philosophy, had an inking of some of the marvelous facts of astronomy. Strangely mixed with wild theories, were the ideas conceived of the solar center and its relation to the earth and heavenly bodies revolving around it. Then we learn that the great Pythagoras actually knew all the chief facts concerning the movements of the sun, the stars and the planets. He even knew that the stars were suns of systems like ours, and advanced the theory that the planets are worlds, cheered and animated with life, similar to, if not like, ours; he was also acquainted with the two physical forces, attraction and repulsion; nay, he knew what modern science has not fully rediscovered; that the visible suns were emanations from and dependent upon an invisible, original, central sun, the sun of the universe, the celestial power whence the forces of nature are derived. We learn that from time to time, there were others who knew more or less of the truths which science proved, even before the time of Copernicus whose knowledge was marvelous, and of Galileo, who had to answer to the Roman heirarchy for knowing more than the Church. Indeed, so much of the Newtonian philosophy do we find in the ancient, that we cannot doubt that he had been exploring the old mines of cabalistic lore, and reached his great discoveries by following up clews gained therefrom.

But the special purpose of this paper is to promote the well-being of mankind in this probationary world, by advocating light and its rays as the great remedial agent for the human organism when from any cause whatever, internal or external, the equilibrium of health is disturbed and disease wastes the body and deranges the mind:—nay, even when there is no clearly defined disease, but only feebleness and an indisposition for physical and mental effort. Of course to apply any remedy successfully, it is essential to know the characteristics and qualities of that remedy, and the features and functions of the organism in the condition of health. There are idiosyncrasies or differences in individuals, but the human organism in health, is much the same, not only throughout each race, but even throughout the family of man; and while some medicines act promptly and effectively in some cases, refuse to act in others, and act injuriously in still others where the symptoms are identical, yet light and its rays will be found exceptional

in this respect; and they seldom fail to effect just what they are designed to effect, when rightly administered. We can attribute this exceptional efficacy of light to the fact that it is essentially and especially nature's remedy, and therefore, peculiarly adapted to assist nature in banishing disease and restoring health.

Bacon declared:—"There can be no real knowledge but that which is based on observed facts;" and the undisputable truth of this fact has been admitted by all eminent thinkers since his time.

A fact new to man's knowledge—the blackening of a white salt of silver presents itself and naturally the discoverer seeks to find the cause to which this phenomenon is due. The salt of silver remains perfectly white as long as it is kept in darkness; but it blackens when exposed to the sunshine. Consequently the change of color, which is all that was at first observed, appearing to be connected with light, calls for an interpretation of the phenomenon. Man starts to solve the problem, forms an hypothesis and says: "The calx of silver separates the phlogiston from the light and retains the superfluous phlogiston of light." Men of science have changed their views; but their mode of reasoning on this phenomenon is as much guided by preconception as was that of Schee.., when he was disposed to refer the decomposition of chloride of silver to phlogiston.

Conjecture is a process, common to every mind; we all frame hypotheses as we endeavor to advance from effects to causes. The strictest inductive philosophy allows of this; but the hypothesis must not be permitted to take the place of a theory, which is an explanation based on a large number of well observed facts. Newton's fundamental rule was: "No more causes, nor any other causes of natural effects, ought to be admitted than such as are both true, and sufficient for explaining their appearances." To account for many of the phenomena of light, philosophers have conjectured that the unknown *something* to which they are due has a wave motion, that the *ether* pervading all space, being set in vibration or tremor, affects the eye with the sensation of light. Since this hypothesis explains the greatest number of luminous phenomena, it is generally received. However, it must not be forgotten that we arrive at this hypothesis by reasoning from analogy. If we cause a stretched string to vibrate, its pulsations are communicated to the surrounding air, and the waves thus produced beat upon the auditory membrane and produce sound. We know the fact of the existence of the air; the fact of the vibrating cord; and if we place some peculiar arrangements of mobile bodies between the

cord and the ear, we prove that the air partakes of the undulations of the string. Upon a fancied analogy, hypothesis creates the *ether*, and then sets it vibrating to produce an effect on the eye of a similar order to that which the air produces on the ear—that is undulations, in one case, give rise to sound, in the other to light. A most eminent European thinker has written: "Notwithstanding all arbitrary suppositions, the phenomena of light will always constitute a category *sui generis*, necessarily irreducible to any other; a light will be forever heterogeneous to a motion or a sound."

Let us, for example, take the strange fact that chloride of silver darkens upon exposure to sunshine, or to daylight; that is what we have to examine into. We may take this simple phenomenon of change as representing all that I shall bring to your notice in this paper, the differences being only of degree. Since this white salt of silver will not darken in the absence of light, it was reasonable that the change should be referred to the luminous element; hence those pictures produced in the camera by the influence of the solar rays have been called photographs. When, however, we proceed with an examination and clearly understand all the conditions under which chloride of silver changes color in the sunlight, we cannot fail to observe the several peculiarities following:

1st. Those rays which give the most light—the yellow and the orange rays—will not produce change of color in the chloride of silver.

2nd. Those rays which have the least illuminating power—the blue and violet—produce the greatest change, and in an exceedingly short space of time.

3rd. The rays which pass through certain yellow glasses have no effect on chloride of silver.

4th. The rays which pass through very dark blue glasses, rapidly change the color.

The yellow glasses obstruct scarcely any light; the blue glasses may be so dark as to admit of the permeation of only an exceedingly small quantity.

5th. Where there is no sensation of light under ordinary circumstances, beyond the violet rays of the spectrum, the chemical change is speedily produced.

Reasoning upon these facts and some others of a still more striking character known to us, it appeared to M. Berard that "solar light consisted of three substances," to which severally belonged, "the calorific chemical phenomena." This hypothesis did not, however, receive

any support from the physicists of his time, and the weight of several eminent names was brought in support of the opposite view. The eminent Dr. Young's experiment demands an attentive consideration however, though it proves no more than this, that, as in the ordinary refracted spectrum, the chemical action is found at its maximum about the region of the violet rays; so in the interference spectrum, the chemical change is confined to the violet rings.

We must certainly come to the conclusion that the rays which produce the chemical changes under consideration, are subject to the laws of refraction and interference like light. But, if they were light rays, it cannot be conceived why, in the yellow, and therefore most luminous rings, no chemical change occurred.

Again M. E. Becquerel and Prof. Stokes have proved that the chemical impressed spectrum—over those spaces which are more especially chemically active—exhibits inactive lines which exactly correspond with the dark lines of that same portion of the spectrum when rendered luminous. This, however, proves no more than that the cause which occasions the absorption of light along certain lines does, at the same time, occasion the absorption of the principle to which the chemical agency is due. This view, as will be seen in the sequel, received also the support of M. Arago, who, although most favorably predisposed to urge the theory of undulations, wherever it was posible to do so, did not fail to perceive that the phenomena of light and chemical action were heterogeneous.

"That there exists some, one, all-pervading principle—an ether—which may, under different conditions of motion, give rise to effects of a dissimilar character, is a probability which is not denied; it is, however, contended that the facts observed do not support such a conjecture in connection with the chemical changes produced by the solar rays."[1]

"The undulatory theory supposes heat—I refer here, entirely to the conditions of the prismatic spectra—to be the result of a set of vibrations of a certain length and rapidity, and the ether thus vibrating, is, by the prism, bent only slightly out of its path. Light is the result of the same ether pulsating to a quicker time, consequently in shorter waves, the refraction being much greater.

Chemical action is produced by a system of vibrations, smaller and infinitely more rapid; while the bending of this set of waves—the chemically active ray—is to a much greater angle than either of the

[1] Robert Hunt, F. R. S., London, 1884.

others. This is the hypothesis; now, take a fact. By means of two prisms, two spectra are formed, each of which produces upon chloride of silver, a chemical change from the green ray to some distance beyond the visible violet. Each spectrum is now so arranged, that the inactive yellow and orange rays of one are thrown upon the most active blue and violet rays of the other. The result is, that the chemical action is entirely stopped. This may be said to be due to interference; but, I must confess, I cannot understand upon what principle the action of rays undulating 535 millions of millions of times in a second, and producing light, can interfere with rays vibrating 737 millions of millions of times in the same period, and producing, as experiment proves, chemical change. To support the view, that light regarded as an undulation produces chemical change, since the chemical cause must reside in—must be—the particular ray and nothing else, it is necessary to prove, that when a colored ray of light is obliterated, all chemical action should cease over the space which belongs to that special ray: and also that when the luminous colored ray is not obstructed, its chemical power should still exist undiminished. Experiment shows in the action of an absorbent medium that the blue rays, regarded as the rays to which the maximum chemical effect belongs, may be entirely obliterated without the chemical effect ceasing; and that under other conditions, the blue ray may appear clear and intense in the spectrum thrown on the chloride of silver, and yet produce no chemical effect."

Robert Hunt says: "After many years of close experimental examination, and an equally long and careful study of the hypotheses applied in explanation of the phenomena of light in the first place, and subsequently to the chemical phenomena associated with light, I cannot bring my mind to adopt the view, which refers the photographic phenomena to the agent producing the luminous and calorific phenomena of the solar rays. As it respects light, I am quite ready to bow to the numerous high authorities who support the undulatory theory. Not so, however, with regard to the chemical radiation."

Careful study shows the amount of support which the following views receive from experiment.

Light, heat and chemical power come to us associated in the sunbeam. No two of the phenomena produced by these agencies are similar. They do not obey the same laws of refraction, although they appear to be capable of undergoing the conditions of polarization, etc.

A diaphanous body for light may be perfectly opaque to the chemical power, and a medium nearly opaque to light may be quite trans-

parent to the chemical principle. Heat, not being the subject here under consideration, does not require any particular mention; the power that we possess, however, of separating light and heat is known accurately.

Therefore, regarding the chemical principle as something distinct from either light or heat, it becomes necessary to establish some term by which it may be recognized. Mr. Hunt's views, based on experiment, as here stated, were not hastily adopted by him, as is shown by the fact that the term *actinism* is now universally adopted.

"The science of thermotics (Whewell), or of thermochroology (Melloni), is considered of sufficient importance to have its nomenclature, and M. Melloni in a paper published in the *Bibliothéque Universelle de Génève*, October, 1841, has entered very fully into the matter. It is therefore essential to the successful prosecution of this inquiry that the third class of phenomena, in the consideration of which I have been particularly engaged, should have a term by which it may be distinguished. Sir John Herschel, in his memoir, "On the Chemical Action of the Rays of the Solar Spectrum," used the epithet, *actinograph* to indicate an instrument of a very ingenious kind, devised by him, for registering the different degrees of chemical power accompanying the solar light, during the day.

At the meeting of the British Association at York, the value of the term was discussed. Sir John Herschel read a paper entitled "Contribution to Actino-Chemistry," on which he spoke before the section of chemistry. It was thought advisable to adopt the term *actinism*, when desiring to speak of the chemical power of the sunbeam.

It may be necessary to remark here, that the chemical powers belonging to light and heat are scarcely to be confounded with actinism. Light does, by exciting vitality, in living organisms, produce chemical decomposition, and there is reason for believing that light acts chemically on dead organic matter, but never on inorganic masses. Heat, as a radiant force, also produces changes of a peculiar kind, but these are broadly distinguished from the effects produced by actinism.

It may be asked, at the outset, what has all this talk to do with the therapeutic study of light, or with physiology or the allied application of the whole science of medicine. I answer my critics thus:—The physical study of light from all its varied physical phenomena is most essential to our knowledge, if we wish to apply it in this domain. Even each ray of the spectrum gives its own specific reaction according to

scientific research, which is now known to us and it is therefore, that specific uses and study of these independent rays in the treatment of disease must be thorough, if intelligent application of them be made. With these remarks, I propose to give here some of the most interesting phenomena discovered in connection with light rays in order to permit you to pass judgment on the value of light from both the physiologic and therapeutic points of view.

There are, in science, few subjects so obscure as that of which I shall speak: What is the essential nature of light? How do we see the universe? How does a luminous body radiate, and by what vehicle do its rays reach our eyes? What are, even, these rays? Man has discussed this great problem for thousands of years. The ancients believed that the rays might be shot forth from our eyes to lay hold of objects far away; Newton thought, on the contrary, that objects emitted luminous particles, which pass through space and strike our retina. Young and Fresnel have since shown that luminous bodies do not emit any material particles, but cause the surrounding fluid to vibrate, as a bell makes the air vibrate. This has led us to imagine, as indispensable to the propagation of light, a certain fluid named *ether*, which is extremely light and disseminated through all space. To Young belongs the honor of having stemmed the flood of authority which, since Newton, had opposed the progress of optics, and of leaving established this theory on a basis which now appears to be definitely assured.

Just as we see the circular waves of a sheet of water succeed one another round the point where the water has been struck, as air condenses and dilates in spherical waves, round the resounding tuning-fork, so the ethereal fluid which fills space gives birth to a series of spherical waves, succeeding one another all round a luminous body. The waves of water are transmitted so slowly, that the eye easily follows their motion; those of the air fly with the velocity of 1,100 feet per second, varying with the temperature and the density of the atmosphere; those of the ether pass through immensity with the dizzy velocity of 186,000 miles per second. The most marvelous fact is that every star, every sun in space, is the centre of constant undulations, which, thus, perpetually cross one another through immensity, without ever being confused or mutually mingled.

In the final analysis, every thing is reduced to several causes which are goverened by certain laws that explain the entire subject. Taking this altogether, it is found to be a universal harmony which

the physical ear cannot hear, but which the intellectual ear can understand, as Pythagoras supposed. And is it not music itself which vaguely lulls us on its seraphic wings, and so easily transports our minds into ethereal regions of the ideal where we forget the fetters of matter? Do not the sonorous undulations of the organ, the sweet quiverings of the bow on the violin, the nervous languors of the cythara, or the still more captivating charm of the human voice, unite the raptures of life with the warm colors of harmony? What is it except an undulatory motion of the air contrived to reach the mind in the depths of the brain and to impress it with emotions of a special order? When the spirited tones of Yankee Doodle and other national airs are borne, in the heat of the conflict, to the excited battalions, or, when, under the Gothic vault, the sad "Stabat Mater" pours out its mournful notes, it is the vibrations which affect us by speaking a mysterious language. Now, all in nature is motion, vibration and harmony. The flowers of the garden sing, and the effect which they produce depends on the number and agreement of their vibrations relatively to those which emanate from surrounding nature. In violet light the atoms of the ether oscillate with the unheard of rapidity of 740 billions of vibrations per second; red light, which is slower, is produced by undulations vibrating even at the rate of 380 billions per second. The violet color is, in the case of light, what the highest notes are in the case of sound, and the red color represents the lowest tones. As we see an object floating in the water, obeying with docility the waves which come from different sides, so the atom of the ether undulates under the influence of light and heat; the atom of air undulates under the influence of sound, and the planet and satellite circulate under the influence of gravitation.

Harmony is in everything. To the eye of the person acquainted with the principle, nothing is more interesting than the crossing of waves of water. By their interference the surface of intersection is sometimes so divided that it forms a beautiful agitated mosaic of rythmical motions, a sort of visible music.

When the waves are skillfully produced on the surface of a disc of mercury, and this disc is illuminated with a pencil of intense light, this light reflected on a screen reveals the harmonious motions of the surface. The form of the vessel determines the form of the figures produced. On a circular disc, for example, the disturbance is projected under the form of circular waves producing the magnificent *chasse-*

croissé, represented in fig. 1. The light reflected by a similar surface gives a design of extraordinary beauty; when the mercury is slowly agitated with the point of a needle in a direction concentric with the circumference of the vessel, the lines of light turn round in a ring under the form of distorted, interlacing threads, revealing one another in an admirable manner. The most ordinary causes produce the most exquisite effects.

The undulations of sound may be expressed to the eye by figures no less harmonious, no less pleasing, than the preceding ones. Let us take in imitation of Chladni, a plate of glass or a thin plate of copper,

Fig. 1.

and sprinkle it with fine sand. Let us deaden one of its edges at two points, with two fingers of the left hand, and pass a bow along the middle of the opposite side. We shall see the sand trembling, falling back from certain parts of the surface, following the sounds obtained and designing the figures here produced (Fig. 2). By varying the experiment we thus obtain these admirable designs, which appear at the command of the bow of the skillfull experimentalist. The notes of the gamut are, besides, nothing else than ratios of numbers between the sonorous vibrations. Combined in a certain order, these numbers give perfect accord. Here, the major mode rouses and enraptures us; there, the minor mode affects us and plunges us into melancholy and reverie. And, yet, there is here but a matter of figures!

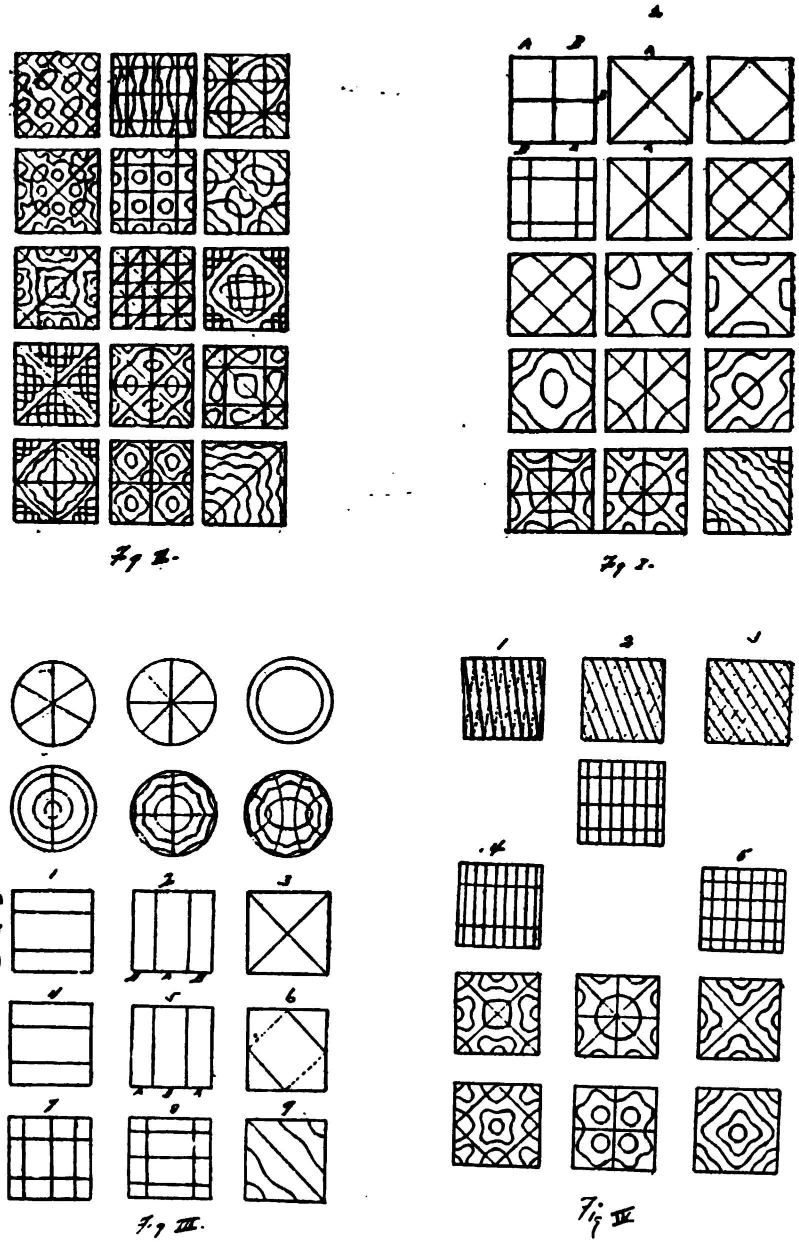

Fig. 2.—The Chladni Figures from Dr. J. Mount Bleyer's article on "Voice Pictures and the Wonders of Sound-Force."

We cannot only hear these sounds, but may even see them. Let us make two tuning-forks vibrate by the ingenious method of Lissajons, one vertical, the other horizontal, fitted with little mirrors reflecting a luminous point on a screen. If the two tuning-forks are in unison and give exactly the same note, the combination of the two vibrations rendered visible on the screen by the little mirrors that inscribe them in lines of light, produces a perfect circle; that is to say, the simplest

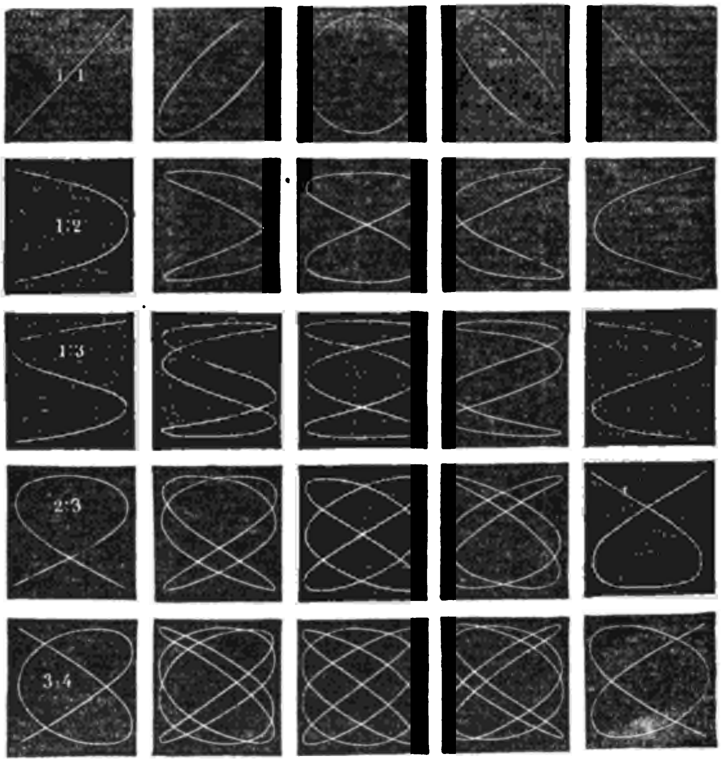

Fig. 3.

geometrical figure; as the amplitude of the vibrations diminishes, the circle flattens, becomes an ellipse, then straight lines. This is the first row of fig. 3 in which the number of vibrations is in the absolutely simple ratio of 1 to 1. If, now, one of the two tuning-forks is exactly an octave from the other, the vibrations are in the ration of 1 to 2, since every note has for an octave a number of vibrations exactly double, and instead of a circle it is an 8 which is formed and modified as we see in the second row. If we take the combination of two tones

of 1 to 3, say *do* with the *sol* of the octave above, we obtain the figures of the third row. If we combine 2 to 3, as *do* and *sol* of the same octave, we produce those of the fourth row. The union of 3 with 4, of *sol* with the *do* above, gives the fifth series.

What is most curious is, that in the complete figures (those of the middle of each series) the number of summits in the vertical direction and in the horizontal direction indicates the ratio of the vibrations of the tuning-forks. Yes, in everything and everywhere numbers rule the world. Many curious experiments among those made by Dr. J. Mount Bleyer, Voice Pictures, and those of Miss Watts Hughs are also evidences of the facts just spoken of.[1]

Why, however, seek in scientific analysis testimony to the harmony which nature has shed over all her works? Although it may be necessary for us to rise to the ideal of music to contemplate the beautiful color of the sky or the splendor of the setting sun; we may on a dull winter day, in the grey and monotonous hours when the snow falls in innumerable flakes, examine with the microscope, some of the flakes and the geometrical beauty of these light crystals (Fig. 4) will fill us with admiration. As Pythagoras said, "God works everywhere by geometry."

The velocity of light has been approximately known for more than two centuries. The honor belongs, however, to the modern physicist, Prof. Harkness, who has made the most correct calculation, in 1891, and found it to be 186,337,000 plus or minus 49.723 miles per second.

Thus, when we see an eruption shoot out from the solar limb, eight minutes have elapsed since the event occurred. When we see a satellite of Jupiter lose its light, it is at least thirty-four minutes since the eclipse took place. When we observe Neptune, we see it as it was four hours previous. When we look at a star, we see it but, not as it was at the moment the luminous ray left it—that is to say, four years ago with reference to the nearest, and ten years, twenty years, fifty years, one hundred, a thousand, ten thousand years, according to the distance. Likewise, a transcendent eye placed at these successive distances would now see the earth as it was four years, ten years, or more according to the distance. Light makes the past an eternal present. Such is the progressive transmission of light. But how shall we represent the action of the sun in the production of this light?

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[1] *Journal of Eye, Ear and Throat Diseases*. Baltimore. Voice Pictures; or the Wonders of Sound-Force; Their Production and Their Photography. Sept. and Oct, 1900.

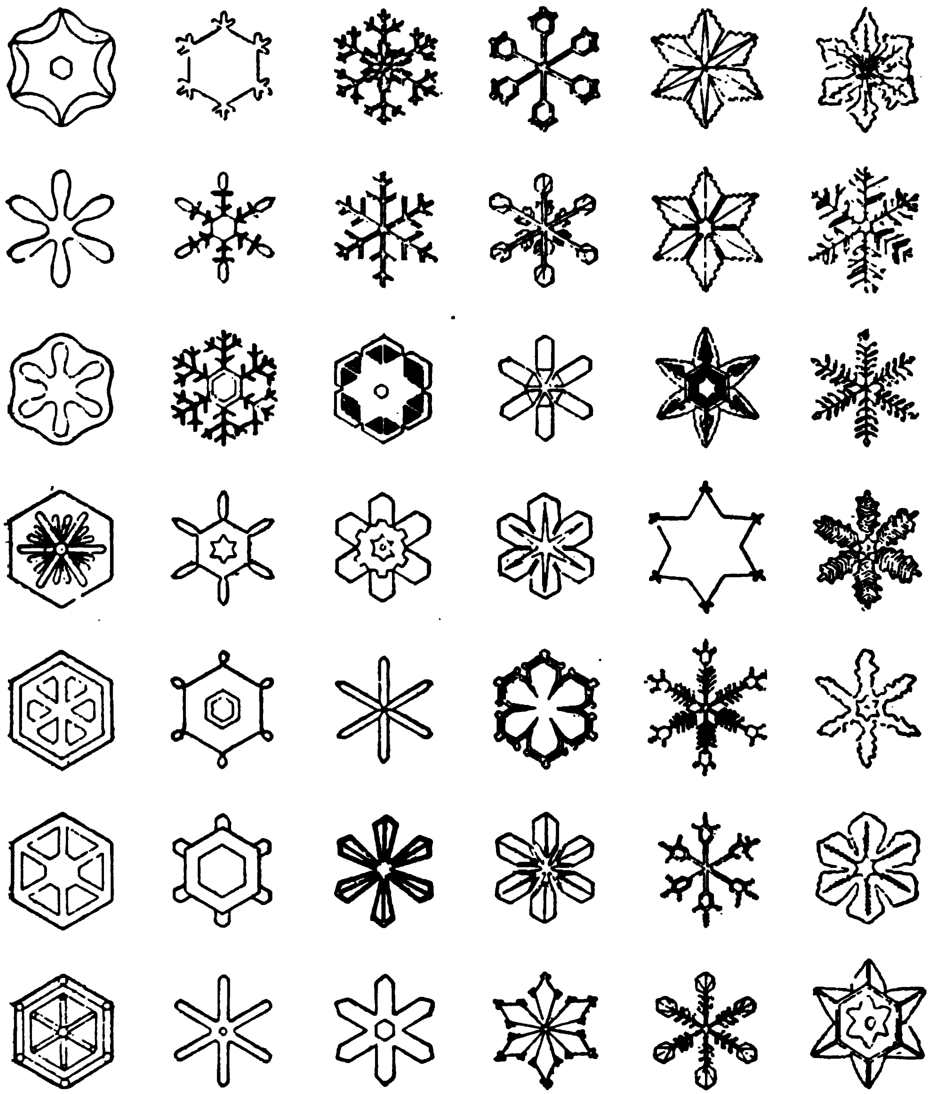


Fig. 4.—*Snow Flakes*—Showing their Geometrical Forms.

Let us remark, first, that the radiant star sends us heat at the same time as light, and that, very often the two species of rays are mixed up. Every-day experience shows us also, that heat raised to a certain degree becomes light. On the other hand, we know that heat is nothing else than a mode of motion: *it is the motion of the molecules*

in rapid vibration which is felt as heat.[1] *Light is otherwise but a vibration.*

There is no solid matter, properly so called, and this is a fact no less worthy of attention than that of astronomical magnitudes and motions. In the densest mineral, in a piece of iron, of steel, of platinum, the molecules do not touch. Cohesion which is the attraction of the atoms, maintains them; but heat increases their distance from one another, more or less, by animating them with a vibratory motion. If this heat is sufficient the cohesion loses its power, the *solid* state disappears and the molecules glide over one another; this is the *liquid* state. If the heat is raised higher, that is to say, if the vibratory molecular motion is more violent, the molecules even escape altogether from cohesion and the body becomes *vapor* or *gas*. Thus, there is no solid matter, and the heat-motion makes bodies pass through the three states. It is assuredly strange to think that our own body is not more solid than the rest, but formed of molecules which do not touch and are in perpetual motion. Perhaps even the constituent atoms of bodies rotate on themselves and around one another. If you had sufficiently good sight to see exactly the materials which compose your body, you would see it no longer, because your sight would pass through it. And how small are the constituent parts! The red globules which color the human blood have the form of microscopic lenses measuring only the hundred and thirtieth part of a millimetre in diameter. It would be necessary to place 130 of these little bodies end to end to form the

[1] Let us strike a piece of iron. The muscular motion of the arm is transmitted to the molecules of the iron, which are in a state of invisible motion, and it is this invisible motion that we call heat. Friction produces heat, and this was the first source of fire among the ancients. Thermodynamics has estimated the mechanical equivalent of heat and we know now that the heat necessary to raise one pound of water 1° in temperature is equivalent to a mechanical force capable of raising 772 lbs. 1 foot in height and conversely.

Heat is a mode of motion. A ball of lead of one lb. falling from 772 feet of height arrives with a velocity of 322 feet per second, and, as its calorific capacity is one thirtieth of that of water, its collision with the ground would raise its temperature by 30° if the soil itself were not heated by the fall. Such a ball shot with a velocity five times greater, or 1,110 feet, would attain a degree of heat twenty-five times higher, or 750 degrees, in striking a target which could not be heated. That is to say, that if the Supreme Will were to stop suddenly, this ball, thus shot out into space would melt on the spot and flow like water.

length of a millimetre. A drop of blood of a cubic millimetre contains about five millions of globules; a litre of normal blood contains 5,000 millions, and there flow in our arteries and veins, twenty-five to thirty thousand millions of these little organic bodies.

Let them become either reduced or multiplied, and we are dead! Let them coagulate, or become cooled or heated, and we are dead! Let them stop, and we are lost! At each throb of the heart, a violent and rapid impulsion projects the blood to the extremities of the members. One hundred thousand times a day, 36 millions of times a year, the same pulsations recommence, until the day when the fatigued muscle stops, and compels us to lull ourselves profoundly in the last sleep.

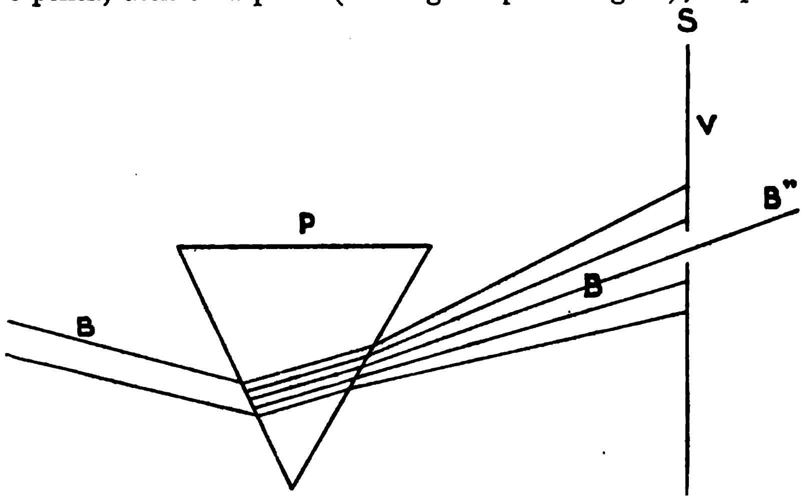
The constituent molecules of bodies do not touch. It is thus, and thus only, that the expansion and the change of the state of bodies under the influence of heat can be explained. We do not doubt the energy of the atomic forces in action around us. Let us heat one pound of iron from zero to 100 degrees; it will expand about 1-800, a span imperceptible to the eye, and yet the force which has produced this expansion would be capable of lifting 12,000 lbs., and raising them to the height of one yard. The power of gravitation almost vanishes in comparison with these molecular forces; the attraction exercised by the earth on the weight of half a kilogramme (about a pound) taken in a mass, is nothing compared to the mutual attraction of its own molecules. In the combination of 1 lb. of hydrogen with 8 lbs. of oxygen to form water, work is performed capable of raising by 1 degree the temperature of 34,000 lbs. of water, or of lifting 15,000,000 lbs. to the height of one yard. These nine pounds of water, in being formed, have fallen molecularly down a precipice, equal to that which would be passed over by a ton of 1,000 kilogrammes rolling down to 46,000 feet of depth!

When a bar of iron is heated and becomes sufficiently hot to be luminous, it sets the ether in vibration at the unheard of velocity of 450 billions of undulations per second.

The length of the wave of the extreme red is such that it would require 38,000 placed one after the other to form a length of one inch. As light travels 300,000 kilometers per second, or 30,000,000,000 centimeters, multiplying this number by 15,000 we obtain the num-

ber given above; all these waves, 450,000,000,000,000, enter the eye in one second![1]

Let us receive a ray of light on a lens in order to produce a very pure pencil, then on a prism (a triangular piece of glass); in passing



The dispersion of white light
by its passage through a prism.

Fig. 5.

Fig. 5 shows how a beam of parallel rays of white light, such as sun or electric light, etc., B, is changed into a fanlike beam, B', by a prism. This fanlike beam falling upon a screen, S S, produces an illuminated band R V, called *spectrum*, which is red at the end R and passes by insensible gradation through orange, yellow, green and blue to violet at the end, V. The beam of light, B, is said to be *dispersed* by the prism. The fanlike beam, B', produces white illumination when concentrated by a covering lens upon a small portion of a screen.

through the prism, this luminous ray is refracted, and in passing out, instead of forming a white point, it forms a ribbon, colored with the tints of the rainbow. In making this experiment, Newton proved that the white light gave birth to all these colors. These are arranged in

[1] What comes from the sun and from all sources of light and heat is not then, to speak accurately, either light or heat (for these are merely impressions), but *motion*, motion, extremely rapid. It is not heat which is scattered through space, for the temperature of space is, and remains everywhere, glacial. It is not light, for space has constantly the darkness seen at midnight. It is motion, a rapid vibration of the ether which is transmitted to infinity, and does not produce a perceptible effect until it meets with an obstacle which ransforms it.

the following well known order:—Violet, indigo, blue, green, yellow, orange, red.

The colors are separated, each according to its character; the most intense, the red, does not allow itself to be turned aside from its path, and passes in a straight line; the orange submits a little to the influence of the prism, and is placed to one side; the yellow submits still more, the green, then the blue, are still milder and weaker, and continue the ribbon. It is this colored streamer which bears the name of the *solar spectrum* (Fig. 6). In reality there are not *seven* colors; there is an unlimited number. In the time of Newton the number VII was still secret.

The length of the spectrum only represents the light, that is to say, the solar rays—perceptible by our retina. Our eye begins to see, when the ethereal vibrations reach the number of 450 billions, and stops seeing when they exceed 700 billions (purple-violet); but beyond these limits nature still acts—unknown to us. Certain chemical substances as those used in the screens for X rays, etc.—the photographic plate is another example—see further than we do, beyond the violet; these are *invisible rays* for our eyes and numerous other examples could be cited for illustrative purposes.

Our ear perceives aërial vibrations from 32 vibrations per second

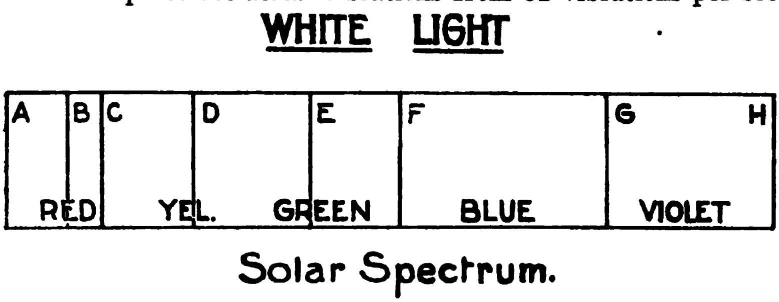


Fig. 6.

(low tones) up to 36,000 (high tones); beyond this we hear nothing. Thus our senses are limited, but not the facts of nature. The colors are, like the notes of the gamut, effects of number; in painting as in music there are *tones*.

It is the molecular arrangement of reflecting or transparent substances, which gives rise to the different reflections of light, that is to say, the colors. A slight difference produces here a blue eye, pensive and thoughtful; there a brown eye, with half-hidden flames; there a look, dull and distasteful. The dazzling rose which blooms in the

flower-garden, receives the same light as the lily, the buttercup, the cornflower or the violet; molecular reflection produces all the difference; and we might even say, without metaphor, that objects are of all colors except of those which they appear. Why is the meadow green? Because it keeps all except the green, which it does not want and sends back. White is formed by the reflective nature of an object which keeps nothing and returns all; black, by a surface which keeps all and sends back nothing. Project the solar spectrum on black velvet; it is absolutely extinct; place a band of red velvet in the blue part

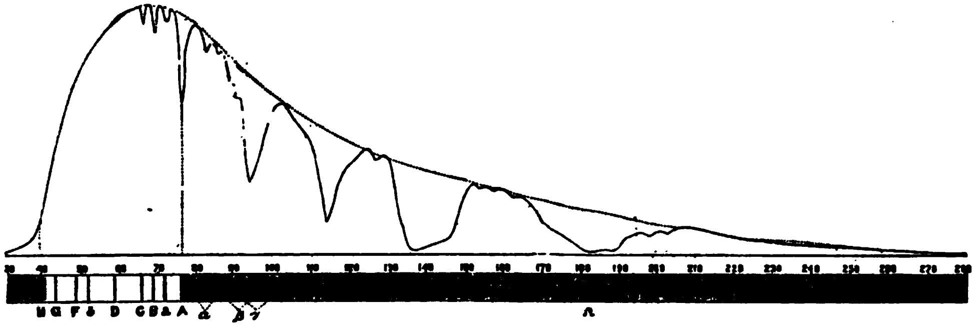


Fig. 2.—Langley's normal bolometric spectrum, showing curves of galvanometer deflections (from the *Photogram*).

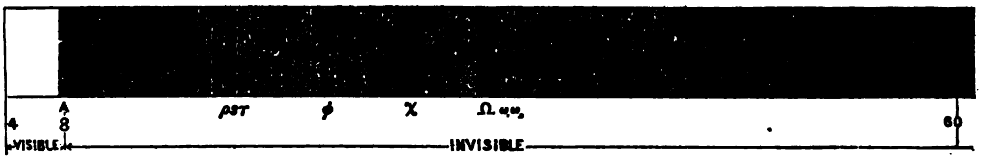


Fig. 3.—Langley's latest spectrum. The white portion on the left is the visible 'spectrum, the shaded portion on the right representing the invisible or infra-red (from the *Photogram*).

* E. J. Wall, F. R. P. S. *Invisible Rays.* London.

Fig. 7,

Fig. 7, a photographic plate reveals the existence of invisible rays beyond V, the ultra-violet rays, especially in sunlight; and a thermopile or bolometer shows the existence of rays inside of or below R, the *infra-red* rays. The portion of the spectrum between R and V is called the *visible spectrum.*

of the spectrum; it becomes black, because, it is not able to send back anything but red, etc.[1]

[TO BE CONTINUED.]

[1] With reference to this, I have noticed a rather singular fact during some experiments. A white ray which passes through a yellow glass is projected in yellow, and a ray which traverses a plate of blue glass is projected in blue; projecting these two colors on each other, on a screen, we obtain a pure *white;* because these two colors are complementary. But, if we place the *same* plates of yellow and blue glass in a single apparatus we obtain green.

OPERATIVE INTERVENTION IN LARYNGEAL TUBERCULOSIS.*

BY W. FREUDENTHAL, M. D., NEW YORK, CONSULTING LARYNGOLOGIST TO MONTEFIORE HOME, BEDFORD SANATORIUM FOR CONSUMPTIVES AND BETH ISRAEL HOSPITAL; LARYNGOLOGIST TO ST. MARK'S HOSPITAL, ETC.

During the last few years, it seems to me, very little progress has been made in the surgical treatment of laryngeal tuberculosis. It was not with the intention of presenting much that is new that this article has been written, but rather in compliance with the request of the Editor of this Journal.

When shall we operate in laryngeal phthisis? Shall we operate at all? In a criticism of a certain book, Dr. A. Kuttner, of Berlin, says that there is at present a general consensus of opinion in regard to the indications for surgical intervention in cases of laryngeal tuberculosis. I cannot agree with him here, as I know that there is a wide difference of views regarding this matter, even in this country. "The question of operative interference is one not definitely settled, nor is it likely to be for some time to come," says Lake in his booklet on laryngeal phthisis, and this is my opinion as well. In Germany and Austria far more cases have been operated upon than in this country and England, and it seems as though some of our American colleagues have gone too far in this direction, i. e., they have not operated at all. Even Dr. Shurly[1] says: "The range of surgical measures for the relief of this disease" (i. e., tuberculosis of the larynx) "is necessarily limited* * * There is no doubt that it" (i. e., Heryng's curettage) "may be a very efficient and practicable measure in cases of isolated ulcerations in the upper part of the larynx, but for a large proportion of cases of laryngeal tuberculosis presenting no limited lesions, but a simultaneous breaking down of many spots separated from each other, this plan of treatment will necessarily be limited in its application."

Masucci[2] believes in Heryng's method, wherever he finds tuberculous ulcerations present. Otherwise he applies lactic acid and iodoform. This author, by the way, found among 198 cases of laryngeal tuberculosis, 25 with *primary* tuberculosis of the larynx. This number is simply appalling to me. Although I have had exceptional opportunities of seeing a large number of cases of laryngeal tuberculosis during the last sixteen years of my practice—at least 800 or 1,000 cases—I

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* Read before the Med. Ass'n. of the Greater City of New York, March 10, 1902.

[1] *Diseases of the Nose and Throat*, p. 313, New York, 1900.

[2] *Internat. Centralbl. f. Lar.*, p. 432, 1901.

cannot remember having encountered one single instance of primary tuberculosis of the larynx. This does not mean, of course, that such instances do not occur; but I believe they must be extremely rare.

Very interesting is a discussion on this topic some time ago, in the Hungarian Society of Otologists and Laryngologists, in which Prof. v. Navratil spoke in favor of the removal of the diseased foci by means of *laryngofissure.* He said that when the pathological changes were circumscribed and the general condition favorable, laryngofissure ought to be resorted to, as all diseased tissue could thereby be removed easily and safely. Baumgarten and Nemai were opposed to such a radical procedure. While the former would remove as much as possible by endolaryngeal methods, Nemai on the other hand, does not favor much surgical interference in such cases for the reason that the patients did not survive long after it.

Pienazek and Grünwald have formulated indications for laryngofissure similar to those of v. Navratil's. Gleitsmann, of New York, is a great believer in curettage of the larynx.

Concerning my own ideas on this question, I remarked in an article published about a year ago: "I am able to report 29 cases the history of which I have found, although I know that more than double this number have been operated upon by me. I will, however, base my conclusions only upon these 29 accurately described cases. Of these 18 were not improved, in 7 a slow amelioration occurred which could be attributed to the operation, and in 4 an almost immediate improvement took place. Of the 18 unimproved cases, 13 were in an advanced stage of pulmonary phthisis, that is, with formation of cavites, etc., and 5 were in the eariler stages. None of these 18 patients experienced any relief after curettement; the majority, indeed, attributed the deterioration in their health to the operation, and in many cases I was of the same opinion. I was struck by the fact that a large number of infiltrations, with or without formation of ulcers, were in the interarytenoid space, forming the well known polypoid excrescences on the posterior wall. In the 7 patients of the second class slow improvement occurred, and I have noted this in affections of almost all parts of the larynx. As this amelioration constantly followed on the surgical treatment, I consider myself justified in ascribing it to the latter. In considering the last 11 cases, one would be inclined to regard these surgical operations in the nature of a salvation, but unfortunately we must not lose sight of the first 18 cases, in which the results were not good. And if I were asked to give the indications for curettement I would not be able

as yet to state them accurately, in spite of the fact that many laryngologists have studied the subject for over a decade. An important factor is that we are still unable to observe or appreciate the extension of the tuberculous process to the invisible portions of the larynx, or the contiguous parts, or otherwise to form an idea of its progress, which is governed by laws as yet unknown to us. As for me, I always regard such intervention as an experiment, and leave the decision to the patient. We learn, therefore, from the above statistics, that while we have been able to effect some excellent results, we have not been spared marked disappointment in a large number, and, indeed, in the majority of cases." Then I continued:

"This was my standpoint somewhat over a year ago. I therefore resolved to try for one year without curettage. There were several cases in which, according to former views, curettement was indicated. Although I was tempted to do it repeatedly, I abstained, and after a year's trial without curettement, I believe my patients are just as well and perhaps better off than they would have been with the operation. Whether in the future I might not come across any cases in which it will be indicated, I cannot say."

Another year has passed by, and now I believe that there are *two indications* to be fulfilled when we do operate; 1st—*intense pain;* 2nd—*dyspnoea.* The covered infiltrations, if I may use this term, I leave alone as long as possible, for fear that they may change into open ulcers by any surigical measure. This is also the opinion of Nemai. The ulcerations, however, I treat topically in most instances, as I have witnessed many satisfactory results from such treatment. I use the orthoform-menthol emulsion, which in many clinics goes under my name, and the exact formula of which is given in my article referred to above.[1] Whenever I can reach the ulcer with my emulsion, and whenever the patient can retain it for a few minutes so that it is absorbed, I am generally quite confident that it will relieve the pain and the dysphagia. During the last year I have again observed repeatedly this beneficial effect of the emulsion, at the New Sanatorium for Consumptives at Bedford Station, where many patients suffering from tuberculous laryngitis have been treated in this manner. Many of these had been treated elsewhere previously with lactic acid, up to 80

[1] Treatment of Laryngeal Tuberculosis at the Montefiore Home—*Jour. Am. Med. Ass'n.*, March 16, 1901.

per cent. or 100 per cent., but felt much better after the use of the emulsion. Of all the cases I have treated in this way, permit me to refer to one occurring in my private practice. I kept this patient alive for nine months with this simple treatment. When he consulted me first he was almost starved as he had been unable to swallow food or drink for nearly a week. His temperature ran up from 101° to 104° constantly, and it is a surprise to me how he could live so long. Still, he was grateful, that he could enjoy a meal again. Of course he was abed all this time and extremely weak. Whenever those terrible pains returned the orthoform-menthol emulsion was applied and he felt better and was able to eat, sometimes even a steak! This condition remained the same up to three weeks before his death, when he could not sit up any more and I was unable to make the application thoroughly.

Now, there are cases where we cannot reach the ulcers well with the emulsion, as those in the interarytenoid fold. We can reach this place, but the fluid does not remain in contact with the parts but runs down into the trachea. As it thus cannot be absorbed *in loco*, it exerts no effect at all. Such cases with interarytenoid thickenings most often give satisfactory results when curetted, but, alas, these are not of long duration. Still, I would recommend curettage in some of these cases when no other means will relieve the pains of the patient, though being fully aware that the amelioration might not in some instances last longer than a week or ten days! As there is very little bleeding during and after operations at the interarytenoid fold, we should remove the infiltrated and ulcerated parts freely and as thoroughly as possible. There is no danger in taking away too much in these instances.

The second indication for endolaryngeal operations is *dyspnoea*. As soon as we have laryngeal dyspnoea we must relieve the patient by every means possible. All will agree on that point. The question is only, how should we operate? Is curettage, tracheotomy or laryngofissure preferable? Excepting in very acute urgent cases, I should never recommend tracheotomy. I see no curative benefit from such a procedure. On the contrary, the patient has to undergo an operation, which is always weakening; has to be bothered with a tube, and derives no relief from his pains. Besides, he is not able to talk, which has a depressing psychical effect on every patient. Laryngofissure would be more advisable, as all diseased parts could be thereby removed. But, as I have said above, most patients cannot stand such operations. They are generally too far advanced and from the long sickness too debili-

tated, to have much vitality left. As a rule they sink rapidly after such an operation.

The only thing left for us to do is, therefore, curettage. Allow me to repeat the history of a patient whom I demonstrated before the German Medical Society of the City of New York, February 3rd, 1902:

M. S., 23 years of age, newsdealer. He became sick a year and a half ago, when he commenced to cough and had "trouble with the throat." He went to a clinic, where he was operated on. Nothing further could be elicited from him. On examination I found a tumor-like infiltration on the right ventricular band. He had dyspnoea, which he attributed to the condition of his lungs. I removed the infiltrated parts and he immediately told me that he could breathe more freely. Although the patient was in an advanced stage of pulmonary tuberculosis, he stood the curettage very easily. In fact, he hardly felt that I was operating on him. There was no loss of blood to speak of, no rise in his temperature, and he felt as comfortably as could be expected. Two weeks later, however, he had a haemorrhage and fever up to 102.5° F. When I examined him again, six days later, at which time he had recovered, I found that there was a recurrence of the infiltration. At the end of another week, this had reached the same dimensions as before. I operated again, and now, i. e., three weeks later, the patient feels well and so far there is no visible recurrence. How long this will last, is naturally uncertain.

Although the haemorrhage occurring after the first curetting might have been a mere coincidence, still there is a possibility that a new active process had started within the lungs right after my surgical intervention. I have observed another case where the same thing happened, viz.: haemorrhage, high fever, etc. We ought to keep this in mind before resorting to operation.

In conclusion I will say that for the last two years I have operated very little on patients with laryngeal tuberculosis, and even in these cases success did not always follow. Still, if we select our cases carefully, we may now and then find a few where these endolaryngeal procedures are of some benefit.

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NUTRITION IN PULMONARY TUBERCULOSIS.

BY A. W. PERRY, M. D., AND ALBERT ABRAMS, M. D., SAN FRANCISCO.

Pulmonary tuberculosis is an affection invariably manifested by disturbed nutrition. This defect in metabolism, anabolic and catabolic is brought about by the conditions which cause and maintain the disease. The words *phthisis* and *consumption* convey a description of the affection, viz.: a wasting away, not only of the lungs, but of the entire organism. The stomach, in fact the entire digestive canal, is implicated in the disturbance of nutrition and, if the healthy stomach is one of the best guarantees against consumption, it is likewise one of the chief aids in restoring the diseased lung. In our experience, one of the best prognostic factors of phthisis is a stomach capable of digesting food. No matter how auspicious the symptoms otherwise, a rebellious stomach is always a bad omen. Good assimilation is proved by gain of weight, provided the same is permanent. Analyses made by one of us in a large number of phthisical cases prove that, while in a number of instances dyspeptic disturbances could not be attributed to any disturbance of the gastric function, yet, in the majority of the patients, amylaceous indigestion associated with hyperchlorhydria was present. In the former group of cases which may be specified as pseudo or nervous dyspepsia, no means more propitious was found to correct the gastric anomaly than the feeding system embodied in the Weir Mitchell method for the treatment of hysteria. Such treatment will often give marvelous results where all other legitimate methods have failed. This treatment means, of course, absolute rest in bed, isolation, massage and the other requirements embodied in this method. No dietetic method will prove satisfactory unless we associate it with those hygienic measures which empiricism has taught are of direct avail in the treatment of the white plague. The etiologic factor of phthisis is by no means the tubercle bacillus alone. The latter organism is a mere guest constrainedly invited by the subnutrition of the host. The last decennia have witnessed the rise and fall of theories which attempted the introduction of bacterio-therapeutic methods.

Any exclusive dietetic method in the treatment of phthisis is manifestly absurd. The organism must be supplied with all the elements concerned in nutrition. Aside from the problem of nutrition, we are confronted by other problems, problems which conciliate the appetite and promote digestion and assimilation. The maintenance of the corporeal weight and strength requires a minimum production

of 2300 calories which was found by Ranke to be produced by the consumption of the following:

Dry proteid matter..............100 grammes.
Fat ....100 grammes.
Starch ....240 grammes.

This is much less than the estimation of Voit and a little more than that of Playfair. The latter found a seamstress living on:

Proteid .... 54 grammes.
Fats ....29 grammes.
Carbohydrates .... 293 grammes.

For the purpose of determining the least food which will prevent loss of weight in an invalid (normal) who presumably does no work and is well protected from cold we may take a mean between the last two estimates and aver that a person with incipient phthisis must take a minimum of

Carbohydrates .... 320 grammes.
Fats ....65 grammes.
Dry proteids ....77 grammes.

No matter how favorable the climatic influence or the action of specific medication, if this equivalent of food is not digested, only retrogression will mark the trend of the disease.

The foregoing estimates of food values may be translated for practical purposes as follows: 320 grammes of carbohydrates, 533 grammes of hard bread; 65 grammes of fat, 65 grammes of fat; 30 grammes of dry proteids contained in the bread, in addition to 47 grammes of dry proteids, the equivalent of which is roast beef, 179 grammes—a total estimate of 777 grammes.

In health we may replace for a time both fats and carbohydrates by meat, but the enormous quantity requisite soon produces disgust and digestive troubles. To maintain an equilibrium on exclusive meat diet requires 3000 to 4000 grammes. For these observations we note that in a person whose appetite is poor as well as in incipient or developed consumption, we cannot change the proportions of the minimum normal diet without increasing the total weight and bulk of the food. If nutrition is to be maintained 3500 g. of meat are required to furnish 2300 calories. Of fat, even in health, in temperate climates not more than 300 grammes can be digested and absorbed; when these large quantities can be tolerated 12 per cent. to 35 per cent. is lost in the faeces. In phthisis there is a deficient assimilation of fats, and we cannot

replace the carbohydrates by the fats to a much greater extent than given in this minimum diet.

The nutritive problems for a person with pulmonary tuberculosis or a condition of marasmus, (whose average weight should be 143 pounds) are the following:

1. Minimum ingestion of 533 grammes of bread, 47 grammes of dry albuminoids which would be represented by 179 grammes of cooked meat, and 65 grammes of fat.

1. To secure the digestion of the albuminoids, starch and fats.
2. The promotion of the passage of the food into the intestines.
3. The absorption and assimilation of the food.

The obstacles to nutrition in pulmonary phthisis are:

A. Difficulties in taking the food.

B. Difficulties in digestion and assimilation.

A. 1. Anorexia.

A. 2. Dysphagia from laryngeal disease.

A. 3 Vomiting from excessive cough.

A. 4. Vomiting from gastric disease.

Appetite is made up of two factors or more. The first is a demand of the tissues for nutritive material to replace that which has been lost by exertion; it comes from all parts of the body to the brain to what may be called the hunger-center although we do not know just where it is located; the perception of this feeling may be inhibited by psychic causes, by toxins circulating in the blood, the result of fever, uremia, diphtheria, and other infections. The second factor in appetite is an empty condition of the stomach; a freedom from food, mucus, fermenting liquids; it is locally expressed as an uneasiness at the epigastrium or behind some part of the sternum, and may be prevented for a time, by pressure or by filling the stomach with any innutritious substance; an excess of the organic acids of fermentation, acetic and butyric, destroy the appetite; while under some conditions an excess of hydrochloric acid alone irritates the gastric mucous membrane, and causes a gnawing feeling which is relieved by taking any food, especially albuminous. This constitutes a pseudo-appetite. A few substances like small doses of alcohol, the vegetable bitters, which increase the motor activity of the stomach, may increase the appetite in phthisis, but only when it is dependent on a moderate stagnation of the stomach contents, not caused by organic or spasmodic stenosis of the pylorus.

The appetite stands in a constant proportion with the amount and strength of the gastric juice which is secreted, when anything is eaten.

Psychic impressions while eating have a far more powerful effect than the contact or presence of food in the stomach.

The bitters and condiments which excite the appetite do not cause an increased secretion of gastric juice when introduced directly into the stomach through fistulae, or when prevented from perception in the mouth or nose by being enclosed in pills or capsules. To be effective in stimulating appetite to the utmost they must be used in solution or powder. It will be seen that the cases of phthisis in which we may hope for increase in appetite from drugs are few, the two most common causes of anorexia being the action of the toxins of the tubercle bacilli and streptococci, and a chronic glandular gastritis.

If the anorexia cannot be relieved by the vegetable bitters, or by treatment directed to any existing stomach disorder, it may be disregarded.

A. 1. Patients must be persuaded to take the food as a duty or as a medicine. If solid food is refused it may be reduced to a thick liquid form and drunk. It is easier to take a thick liquid food than to chew solid food soft enough to swallow. Very large quantities of liquids (3000-4000 g.) are to be avoided, as Debove and others found dilatation of the stomach to develop soon after such a diet.

A. 2. The violent spells of coughing in laryngeal disease are frequently caused by small pieces of food becoming detached from the alimentary bolus and falling into the larynx; so far as this occurs any of these foods may be gelatinized by heating and adding to the liquid, two per cent. of gelatin which has been soaked in water.

A. 3. Vomiting from cough may be controlled by sedatives such as heroin, codein, antipyrin, etc. If the cough is caused by laryngeal irritation insufflations of orthoform are indicated.

A. 4. Emesis of gastric origin may be obviated by treatment directed toward the stomach. Daily lavage with hot water not only inhibits gastric anomalies but improves the appetite, digestion and assimilation.

The method of forced alimentation (gavage) was devised by Prof. Debove in 1881. For those patients who would not, or could not eat or retain sufficient food, or when the food is vomited, it was found that when given through the stomach tube it was oftener retained and assimilated in enormous quantities. A preliminary washing of the stomach before the gavage was often effective. His results were confirmed by others. Although forced alimentation is not suited to many cases of phthisis, yet we learn from these results that the digestive and assimilative capacity are often far in excess of the appetite, or toleration of

the stomach; also from the good effects of the preliminary lavage, that chronic gastritis may be an obstacle to retention, and that it may be easily remedied by the lavage.

Records of examinations of faeces from phthisical patients rarely show undigested residues, an effective argument in favor of superalimentation.

Digestive disturbances may also be induced by anomalous digestive secretions and tardy intestinal peristalsis.

B. 1. During the febrile period of phthisis the salivary secretion is entirely suspended, and its digestive capacity is enfeebled. Its place can be supplied to some extent by very slow chewing and by the use of starchy food partly transformed towards dextrose with vegetable diastase, during meals. The gastric secretion is oftener excessive than not, excepting in the last stages of phthisis.

The biliary and pancreatic secretions together effect the digestion of the fats and when deficient, as is usually the case the Pancreatic Pepetonising Powder is reliable and invaluable. If the biliary and pancreatic secretions are entirely cut off from the intestine of dogs, fats when emulsified are absorbed to the extent of 50 per cent.

FAECAL EXAMINATION.

Whether the food ingested is digested and assimilated may be judged grossly and after some days by loss or gain in weight excluding, of course, alterations due to oedema. A much better and quicker method is founded on an examination of the faeces for undigested food.

There may be found (indicating serious derangement of digestion) pieces of muscular and connective tissue visible to the naked eye; undigested starch enough to produce a bluish color when the faeces are moistened with iodine.

The presence of starch grains *in small amount* visible under the microscope, and also of muscular fibres does not show any serious digestive disorders. Fat in amount from 2 to 4 per cent. is always present in faeces and the presence of over 6 per cent. shows serious disorder. Faecal examinations are not more disagreeable than the examination of tuberculous sputum. The examination for fat to be of service must be a quantitative one. We have found the following to be comparatively easy and not unpleasant:—With 30 grams of faeces mix an equal bulk of plaster of Paris, one quarter bulk of powdered charcoal, and 10 drops of sulphuric acid. This makes a mass which is dry enough to powder in a few hours, and may be exhausted on a filter with ether or benzine, and the fat determined by weighing, on evapor-

ation of the solvent. The charcoal removes all the smell, and the process is far easier than drying the faeces by heat, and powdering, or by shaking up with ether and water. Having by these methods determined the deficiency of any particular digestive function it can be treated with more certainty of success.

Most phthisical persons do not eat enough. It will not do to allow them to be guided by their appetites. They must be persuaded to take the minimum we have given, unless they actually vomit. If this cannot be remedied by medicines gavage may be tried.

The reasons for superalimentation are:

1st. The digestive capacity is far greater than the appetite, as shown by Debove's results.

2nd. Our examinations made with faeces from twenty consumptives in the first and second stages of the disease have shown no abnormal amount of meat fibre or starch, and .09 to 3 per cent. of fats. As these cases were taking as much food as they (thought) could, absence of undigested or unabsorbed residues in the faeces shows that the digestive power of the patients was not being worked up to its fullest capacity, which is certainly the important point in the treatment.

3rd. The results at Dr. Walther's Nordrach Sanatorium and others conducted on the principle of over feeding the patients show the excellent results which can be attained by superalimentation.

The more exact our directions, the more faithfully they are carried out; consumptives must take a minimum of:—

Starch 320 g. Represented by		Fats 65 g. Represented by		Dry Proteid 77 g. Represented by	
Dry toast	592 g.	Butter	77 g.	Roasted meat	226 g.
Bread	729 "	Cream	300 "	Boiled "	226 "
Crackers	508 "	Fat	65 "	Eggs	550 "
Sugar	256 "	Oil	65 "	Brains	960 "
Brown flour	400 "	Bacon	68 "	Fish	385 "
Roasted flour	400 "			Meat powder	110 "
Cereal foods	400 "			Plasmon	103 "
Boiled rice	1680 "			Somatose	96 "
Mushes	1800 "			Tropon	86 "
				Eucasein	100 "
				Sanatogen	100 "

The weighing of food at the table is easily done by a post-office spring balance hooked into a double slip of paper holding the food.

The following plan of feeding unwilling patients is offered:

All food is brought to the state of a liquid, thick enough to be drunk easily; this liquid consists of milk slightly thickened by boiling with 2 per cent. of corn starch or gelatin, in which is suspended 14 per cent. of roasted flour or some of the dextrinized foods of commerce, such as Imperial Granum, Mellins Food, etc.

In case milk disagrees, we may use thin barley-gruel or any other similar liquid and suspend in it the carbohydrate-food.

The requisite amount of albuminoids is supplied by suspending in these thick liquids from 70-80 grammes of meat powder or Tropon, Plasmon, Somatose, or Eucasein. From 12 to 14 per cent. of any of these finely powdered preparations can be suspended in thin mucilaginous liquids, making a mixture which can be easily drunk.

To get enough nutriment in 2000 grammes of liquid, we may give 1500 c. c. milk, thickened by boiling in it 30 grammes of corn starch, in which is suspended 210 grammes of brown flour.

Dextrinized with this may be taken 500 c. c. barley-gruel or other mucilaginous liquid in which we may suspend 70 g. meat powder, Plasmon, Somatose, Eucasein, or Tropon.

This schedule gives a normal nutriment (quantity), and furnishes 2387 calories, with only 2 litres of liquid.

The advantages of preparing food in this way are: It can be taken easier than solids and semi-solids, owing solely to the carrying power of the liquid. The amount of liquid to carry this food is so moderate that it will not overburden the stomach, and cause or develop a (preëxisiting) dilatation, as found after an exclusive milk-diet of 3500 to 4500 c. c.

The question of extra-buccal feeding is an important one in dealing with the nutritive problems in phthisis. Two avenues, the rectum and skin, present themselves for such feeding and may be employed in uncontrollable vomiting, hematemesis and other gastric disorders, or they may be used in supplementing conventional nutrition.

Rectal nutrition. It is now conceded that enemata subserve a very useful purpose in nutrition. The fact, however, must be borne in mind that the rectum is endowed with the power of absorption only. Its capacity for digestion is so limited that it need not enter into consideration. Investigations demonstrate that certain food products are easily absorbed. Such products, in brief, are meat juice and peptone, raw eggs, small quantities of fat, milk and solutions of sugar. Each enema should not exceed 300 grammes of fluid, otherwise peristalsis is excited and the enema is discharged. As a result of long continued

clinic and physiologic experience, Leube presents the following nutrient enemata which may be employed with advantage:

1. Peptone enema: 60 grammes of peptone to 300 grammes of milk.

2. Egg enema: 3 eggs in 300 grammes of milk with 3 grammes of salt.

3. Starch enema: 60 grammes of starch to 300 grammes of milk.

4. Egg-starch enema: 300 grammes of milk, 3 eggs, 3 grammes of salt and 40 grammes of starch.

To maintain daily nutrition in the average individual, 2000 calories are necessary. Each of the above enemata represents only 300-450 calories, therefore, if employed three times a day, we would succeed in furnishing the patient with only one-half the necessary calories.

SUBCUTANEOUS NUTRITION. For this purpose oil which has been sterilized by boiling is the best agent. From 50-100 g. of warm oil are thrown under the skin by means of a large syringe to which a needle is attached. At least an hour is consumed in injecting the oil. If we supplement the rectal by the subcutaneous nutrition we may succeed in furnishing the patient with the necessary calories to maintain normal nutrition. Thus two nutrient enemata a day composed of 300 grammes of milk, 40 grammes of starch and 3 eggs, 1100 calories together with 100 grammes of oil (930 calories) afford 2030 calories.

INTRATRACHEAL MEDICATION IN DISEASES OF THE RESPIRATORY TRACT.

BY JOSHUA L. BARTON, M. D., NEW YORK.

The employment of this method, in a field of labor well adapted to test its efficiency to the utmost, during a period of seven years has led the writer to regard it as one of the most valuable means of treating persons afflicted with diseases of the trachea, bronchi and lungs.

In simple acute tracheo-laryngitis, tracheo-bronchitis, bronchitis, and asthma when secondary to bronchial disease, a rapid cure may be confidently predicted. The subacute and chronic forms yield more slowly, owing to changes in the mucous membrane, but persistent treatment even in these obstinate cases will give the most gratifying results, while in pulmonary tuberculosis and in phthisis the beneficial effect of topical applications is very marked.

It is not strange that many physicians look askance at this method, since nearly every one can recall cases of severe cough and strangula-

tion caused by the accidental dropping of a little water or a crumb of bread into the larynx. Naturally the following objections are suggested:

1. Interference with respiration.
2. Excitation of severe cough.
3. That it can be used only by a laryngologist.
4. That it has no value as a therapeutic agent.

An examination of the anatomical parts concerned in the act of respiration will convince the most skeptical that the first objection has no foundation. Respiration may be arrested by destruction of the cerebral nerve centres, by section of the pneumogastric nerves or by shutting off the supply of oxygen. In this instance we have to deal only with the fear of flooding the respiratory tract.

If we recall the fact that the human trachea is about four and one half inches in length, and from three fourths of an inch to one inch in diameter,[1] and that it opens into the bronchi which in turn open into the lungs, the respiratory surfaces of which are estimated to be 130 square meters,[2] and that this large pulmonary surface is covered with epithelium which is capable of absorbing liquids as well as gases and vapors,[3] and furthermore that the quantity of liquid thrown into the trachea at one sitting rarely exceeds one-half ounce given one drachm at a time, it is plain that there is no danger of shutting off the supply of oxygen.

The fear of inducing severe cough is equally groundless. It should be borne in mind that remedies introduced into the trachea are dissolved either in olive oil, distilled glycerine or in one of the bland petroleum oils, substances which do not irritate even that portion of the larynx supplied by the superior laryngeal nerve, and that when these solutions are properly administered the quantity which comes into contact with the larynx is so small that very little cough is produced. Those portions of the respiratory tract below the larynx are much more tolerant. Solutions which would greatly irritate the larynx produce only a feeling of comfort when applied to the mucous membrane of the trachea, bronchi and lungs.

In a paper read before the Laryngological Section of the Academy of Medicine in 1896, I outlined the technique then used which presupposed a knowledge of laryngology. A larger experience has shown

[1] *Kirk's Physiology*, page 380, Edition 1892.

[2] *Gray's Anatomy*, page 927.

[3] *Dalton's Physiology*, page 274.

that special laryngological training is unnecessary. This method of treatment can be used by any physician, and furthermore patients may be instructed to administer it to themselves.

An ordinary aspirating syringe holding two drachms, to which has been fitted a curved endolaryngeal tube seven inches in length is all that is required in the way of apparatus.

The patient is seated with his tongue drawn out, and his head thrown back. He is instructed to breathe out. The physician then introduces the tube, keeping in the median line and carrying the curved portion over the base of the tongue, raising the elbow high enough to insure the point of the tube passing under the edge of the epiglottis.

The patient is then instructed to avoid swallowing, to keep the tongue well drawn out and to take a deep inspiration. As the patient inspires, the contents of the syringe is thrown quickly into the larynx, the ingoing current of air causing it to pass directly into the trachea which causes almost no laryngeal irritation.

This process is repeated, giving one or two drachms at a time until the requisite quantity for one treatment has been administered.

THERAPEUTIC VALUE. Any form of medication is useful, just in proportion to its power to fulfill one or more of the following indications:

1. To remove the cause of the disease.
2. To modify the course of the disease.
3. To restore normal physiological action.
4. To disinfect the diseased tract.
5. To add to the comfort of the patient.

The value of remedies depends upon the manner in which they affect the organism. If they promote constructive tissue-metamorphosis, they are tonics. If they increase retrograde tissue-metamorphosis they are alteratives. If they destroy microörganisms or morbific germs they are antiseptics.

Methods of medication as well as remedies have a therapeutic value. It is well known that medication by inunction or by hypodermic injection is frequently more efficacious than medication by the stomach.

Intratracheal medication has like obvious advantages.

It is objected that medicine introduced directly into the trachea, bronchi and lungs, passes over and into portions of the respiratory tract which are not diseased. This is true. It is also true that remedies given by the stomach affect not only the diseased portion but modify the nerve action of the whole body.

It is probable that the good results of medication may be largely due to this fact. It has long been recognized that if one member suffers all the members suffer with it, and that by a modification of the action of the whole nervous system, the normal equilibrium is the sooner restored. Primarily, a local impression, a topical effect is intended, but it is probable that no action can be confined to the part acted upon. Absorption takes place, producing effects analagous to those produced when the remedies are given by the stomach, in addition to which there is a mechanico-therapeutic action due to a stimulation of the end-organs of the nerves supplying the part, causing a reflex tonic influence to be sent to the diseased tract from the brain or spinal cord, or from the ganglionic centres, which have been shown by Vulpian Galz and Heidenhain to exist in the nerve supply of the vessels and which perform the functions of nerve centres within their immediate sphere.[1]

The effect of stimulating an afferant nerve, by its influence on the vaso-motor centre may be either to dilate or to constrict the arteries, producing a paradoxical effect, viz.—a general vascular constriction and therefore a general increase of blood pressure, but at the same time a local dilatation which must evidently have an immense influence upon nutrition by increasing the flow of blood through the part. The vaso-motor and trophic systems are peculiarly impressionable to peripheric stimulation and therefore through the intermediation of this nervous apparatus important changes may be wrought by even slight counter-irritations.

This plan of treatment has an immense advantage over all other methods. The remedy is applied directly to the irritated mucous surface in a quantity sufficiently large to immediately alleviate the most distressing symptoms. In a certain number of cases the antiseptic effect is very pronounced, as shown by the longer interval between the febrile attacks and by their lessened intensity when they do occur.

In cases characterized by an atrophic condition of the tracheo-bronchial mucous membrane or pulmonary disease with cavitation leading to retention and decomposition of the secretions, intratracheo-bronchial medication rapidly changes the character of the sputa and removes the disgusting fetor of the breath.

This alleviation of annoying symptoms adds greatly to the comfort of the patient. He breathes more easily and deeply. His appetite improves. His color is better. His courage returns. Hopeful-

[1] *Kirk's Physiology*, Edition, 1896, page 241.

ness takes the place of despair and he is encouraged to make a determined effort to regain his health.

Notwithstanding its many advantages, intratracheal medication is not brought forward as a sure cure for tuberculosis, but rather as a powerful adjunct to other treatment and I venture to hope that this article may contribute something towards calling the attention of the profession to a method of medication at once simple, safe and easily applied.

CULTURE PRODUCTS IN THE TREATMENT OF TUBERCULOSIS.*

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In presenting a paper before this society upon the subject which I have chosen, I recognize full well that there is no specific remedy for tuberculosis, which is recognized by the medical profession generally; none which corresponds to antitoxin in diphtheria, the iodides and mercury in syphilis, or quinine in malaria; yet there are certain remedies which, while they have enjoyed only a limited trial by the profession, are found to have a specific action upon tuberculous tissues wherever found.

That the value of these products has not been recognized is due to a misconception of what should be expected of such remedies. Antitoxin is recognized as the anchor of hope in diphtheria; yet the profession well knows that, to be efficacious, it must be used early; and all things being equal, the prognosis varies with the early or late administration. So it is with other diseases. The earlier the case falls into the physician's hands the better. In surgery, we know the knife is a specific for many troubles; yet its field of usefulness is limited, and after a certain point in the disease has been reached this specific fails. While the field of these specifics is limited, yet their value is recognized and in no way impaired by the fact of this limitation. On the other hand, the profession bends every energy to bring the cases under treatment during the period when the remedies are valuable. In the case of tuberculosis, however, the profession has not been satisfied with a remedy of limited value. It has been unreasonable, and demanded that a remedy to be useful and to be recognized must not only cure tuber-

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culosis, but remove dead and decaying tissue; not only cure the disease, but remove all results caused by the disease. Such demands are unfair and preposterous. If the same test were applied to other remedies, how many would stand? In tuberculosis we must demand no more of a remedy, and no less, than in other diseases. As the followers of the healing art we should seize upon everything that will help, and apply it to the advantage of the patient, not discard even the smallest thing that will aid us to combat disease. To correctly estimate the value of a specific remedy in tuberculosis, we must properly define our disease. We must distinguish between tuberculosis and consumption. Tuberculosis in its early stages—that is, while it is pure tuberculosis—is a very curable disease, yielding as readily to treatment as typhoid fever or pneumonia. But when this pure tuberculous process has changed, and its place has been taken by ulcerations, cavities, cheesy nodules, and these often surrounded and embedded in fibrous tissue—in other words, when consumption has supervened—then the picture is different. We have not pure tuberculosis to deal with, but the results of tuberculosis. Tuberculosis itself will yield readily to treatment, but these results are very difficult to combat, and a remedy for the former should not be expected or required to remove the latter. It would be as reasonable to ask of a remedy for a surface ulcer to remove the resulting scar. So, if we have a remedy at our command which can be shown to have a specific action upon tuberculous processes, we should hail it with delight, not demand of it that it remove cavities and cheesy nodules; but we should improve our method of diagnosis so that we might recognize the disease while it is in the purely tuberculous stage, and while the remedy is applicable.

Advances in the field of medicine, as elsewhere, are slow to be recognized. Every new theory must force its way against the prejudices of preconceived ideas; and, if at all revolutionary, meets most bitter opposition. Harvey, when he had called his *confrères* together and made a thorough demonstration of the circulation of the blood, is reported to have said: "Alas, I cannot make a single man over forty-five years of age believe it!" Although vaccination has almost driven smallpox from civilized lands, yet we now and then meet so-called physicians who are opposed to vaccination. The germ theory of disease is doubted by some, and the efficacy of antitoxin is not unquestioned. Is it any wonder then that the value of culture products in tuberculosis is not recognized?

It is unfortunate that the field of medicine is so large that we can-

not prove the value of new theories for ourselves. Such independent work and thought would be wholesome, but with the cares and responsibilities which are forced upon us, we can only investigate some small field wherein our greatest interest lies, and this in a very unsatisfactory way. The greatest portion of our knowledge we are obliged to take second-hand from men whom we recognize as authorities; and, when we know how often they are mistaken, it behooves us to do as much original investigation as possible. Conservatism is a safeguard, and it is praiseworthy, but it should not lead to blindness. New methods of combating disease should be weighed carefully and tested thoroughly before acceptance or rejection; but it is hardly fair or just for the great majority of the profession to reject a remedy, although they have never tried it, simply because certain noted men say it is useless, when at the same time other equally noted men are obtaining good results by its use. In the examination of sputum, one positive evidence of bacilli will outweigh a dozen negative results; so in the employment of new remedies one unquestioned result should outweigh a dozen failures. By the use of the culture products in the treatment of tuberculosis many cures have been made; but these have been lost from sight, because in certain other cases cures were not effected.

In 1890 the medical world was startled by the announcement that Professor Koch had discovered a lymph which would cure tuberculosis. This news was received with delight. Unfortunate victims from all parts of the world looked to Berlin for life. Physicians left their busy practices, and went to see the great master administer his reputed cure. Perhaps there never was a discovery made in medicine from which such great results were expected. But, alas, how quickly these hopes were blasted! Those who saw the administration of the remedy at this time of unfortunate trial were so disappointed in not seeing patients in the last stages of consumption restored to health that they overlooked all good results that were obtained, and returned to their respective homes with nothing but hostility in their hearts toward the new lymph. They did not take into consideration that tuberculin was a new remedy on trial for the first time, and that its limitations and the proper mode of its administration were to be determined by clinical experience.

It must be remembered that Professor Koch was forced to disclose his remedy before he was ready, and before he had determined the mode of its action, or had learned the proper method of administration. He was in a new field, and should have had the assistance of the med-

ical profession in determining the use of his remedy. But with that respect for authority which is characteristic of the German race, those who believed the remedy to be used in a faulty manner were afraid to say so, lest they should offend the master; so the improper administration continued, with its disastrous results to tuberculin.

A careful study of the literature of the time should convince any fair-minded man that, whether or not the remedy possessed any virtues, it was not used in a proper way. And when we consider it in the light of our present knowledge of the culture products, we are able to point out the mistakes which then were made, and judge it according to its actual worth.

In the first place, Professor Koch recommended its use only in the early stages. In this he was right, for its curative value lies in its action upon the newly formed or recent tubercles. While there are areas of greater or less extent even in advanced cases where recent tubercles are found corresponding to the more recent advances of the disease, yet when a remedy of such great importance is on trial it is wrong to cripple its usefulness by the choice of improper cases. If used properly we can expect and often see the recent tubercles disappear from a patient's lungs, in whom the disease is far advanced, and whose vitality has been much reduced; but when the eyes of critics are sharpened, it is better to confine the remedy to those cases wherein it is known to be of value. In spite of Professor Koch's recommendations, patients whose lungs were riddled with cavities, and whose constitutions were worn by the long-continued drain of suppuration, and whose vitality was destroyed by continued high fever, were subjected to treatment, with the only result that should have been foreseen—disappointment. In order to have satisfied those who were posing as critics of tuberculin, it would have been necessary for the remedy to have removed dead and dying tissues, to have cured suppurating foci, to have removed all symptoms resulting from a heart long overburdened, and to have restored to normal a system whose organs were all more or less diseased. When such a remedy has been found, it will be a specific, not only for tuberculosis, but for all diseases to which mankind is heir. But even in these cases, unsuitable as they were, had the remedy been administered in the proper doses good results might have been obtained, and at least no harm could have been done.

The second mistake which was made was the administration of too large doses. This dosage depended upon the erroneous view which Professor Koch held as to the manner in which tuberculin acted. He believed that the end desired was the destruction of the granulation

tissue surrounding the tubercles, thus allowing the defensive forces of the body to attack the germs *in situ;* or by liquefaction to secure the expulsion of the tuberculous tissue. In order to produce this result doses were given which caused severe reactions, both local and general. The temperature was often elevated to 104° and 105° F., and the remedy administered at such intervals that the patient was kept in a constant feverish condition. As a consequence the patients lost appetite, became emaciated, and soon succumbed; and all such results were recorded as scores against tuberculin. Instead, they should have been considered as due to the *improper use* of tuberculin. Strychnine is a valuable remedy and capable of producing brilliant results when administered in doses of 1-60 to 1-20 of a grain, but when given in 1-grain or 2-grain doses it destroys the patient. This poisonous effect is one of the characteristics of the drug, and is taught to the profession; but in no way handicaps the remedy, for the result desired is obtained without the poisonous effects. So it is with tuberculin. In small doses it is capable of producing beneficial results. In large doses it produces poisonous results. But the fact that it was administered in poisonous doses almost exclusively in the early period of trial in 1890 and 1891 caused the poisonous symptoms to be considered as the only ones which the remedy was capable of producing. Instead of recognizing the brilliant results in lupus and early stage cases of pulmonary tuberculosis, even when the remedy was used in what would be considered to-day a faulty manner, and thus making the physician's armamentarium richer by one valuable remedy, the hostile critics could see nothing but harm; so they gave out the erroneous idea, from which the medical world has not yet freed itself, that tuberculin can produce no good results, but on the contrary is liable to do much harm. To show the method of administration, I will cite some examples from the literature of that time.

January 17, 1891, a patient in von Leyden's[1] clinic had a paracentesis made, removing a clear, serous exudate. Examination showed râles in the right apex, relatively dull percussion note, slightly tympanitic, and diminished respiration. The spleen was somewhat enlarged. Temperature 100.4° F.; next day after the operation, 102.5° F. On the 19th an injection of two milligrammes of tuberculin was given. By February 12 the patient had received ten injections, the last being 50 milligrammes. During the period the patient became rapidly worse. On February 10 the temperature reached 104° F., where it remained

[1] *Berliner Klin. Wochenschrift*, 1891, p. 237.

continuously until the patient's death on the 19th of February. Reutimeyer[1] reports a case in which he gave eleven injections in eleven days, in spite of reactions of 104° F.

These two cases are not exceptions, but such was the method employed generally when tuberculin was first put upon trial. Had these patients received as an initial dose one-tenth milligramme, and then a gradually increasing dosage, so as to avoid fever reactions, they would have had the benefit of the specific action which the remedy possesses over tuberculous foci; many of them would have been benefited, some would have been cured, and culture products to-day would be warmly praised by the medical profession in the treatment of tuberculosis.

Besides being held accountable for the effect produced when used in unsuitable cases, and when administered in poisonous doses, tuberculin was also held responsible for all post-mortem findings. Pathologists who before had found so little interest in tuberculous lungs that they had only given them a casual glance, now began to make the most minute examinations. Every finding was carefully recorded and ascribed to the advent of tuberculin.

Perhaps the work of Virchow had more to do with the discrediting of tuberculin than that of all other critics combined; and, strange to say, those who have quoted him have made his utterances much more hostile than they really were. Virchow made the post-mortems and recorded his findings; but much of the interpretation that has been put upon them is not his, but that of others.

One of the commonest objections that has been urged against tuberculin is that it is prone to produce acute miliary tuberculosis; and critics assign the authority for this statement to Virchow. This he did not say. The error comes from a juggling of words. He said that in the various organs of the body "miliary or submiliary nodules were observed," but did not ascribe them to the remedy, except in a suggestive way, saying:[2] "I have only shown what we have found; I believed —and I think there is here sufficient evidence—that this exhibition would show the magnitude of the danger which might arise. How frequently this danger arises, in what cases it arises, by what it is especially caused, are questions that can be definitely decided only after long research." Krause,[3] in a review of Virchow's criticisms, says: "In

[1] *Berliner Klin. Wochenschrift*, 1898, p. 124.

[2] *Berliner Klin. Wochenschrift*, 1891, p. 191.

[3] *Journal of Tuberculosis*, vol. ii, p. 246; translated from *Zeitschrift fuer Hygiene und Infectionskrankheiten*, vol. xxxiii, 1900.

order that they might account for these miliary tubercles, so frequently observed, Virchow and his pupils, especially Hansemann, assumed that the eruption of tubercles occurred regularly during the injections. For this assumption both master and pupil are without a proof, because pathological anatomy has not yet found a criterion by which one can determine the age of a tubercle." To make tuberculin responsible for these "miliary and submiliary nodules," it would be necessary at least to show that they occurred only during its administration; but these same miliary nodules are found when tuberculin has not been administered. Petruschky[1] reports that he has observed constantly fresh miliary crops around old tuberculous foci in consumptives who have died with evidences of secondary infection, but who had never received tuberculin.

That acute miliary tuberculosis could be so frequently produced by the injection of tuberculin as to make it one of the chief dangers of its administration is almost too absurd to receive notice; but since it has been so generally believed, we will examine into the supposed danger. Acute miliary tuberculosis can only be produced in one way, and that is by the tubercle bacilli finding their way into the general blood stream, either "by the rupturing of a tuberculous focus directly into a pulmonary vessel, or into the thoracic duct." How often this happens we may judge from the investigations of Kossel,[2] who together with a number of other investigators examined the blood in 800 cases that were treated with tuberculin, with only three positive results, and one of these doubtful. He expressed his opinion as follows: "I am convinced after a great number of negative results that a dissemination of tubercle bacilli into the general blood stream of patients treated with tuberculin does not take place." That such an accident might occasionally happen when the remedy was administered in doses sufficient to cause high local as well as general reactions can be believed; that it would happen during the proper administration of tuberculin can scarcely be conceived. However, granting that such an accident should occur during either the faulty or proper administration, it would carry little evidence against the remedy, for a focus which would break down so easily under the use of the remedy would have likely broken down without it, and, scattering the bacilli in the blood stream, cause the same acute miliary tuberculosis.

[1] Paper before Berlin Congress; quoted in *Journal of Tuberculosis* vol. ii, p. 63.

[2] *Berliner Klin. Wochenschrift*, 1891, p. 471.

Another supposed danger attending the use of tuberculin was that it might "mobilize latent foci" which were "apparently innocent." Such a result has never been shown; so the burden of proof still rests upon the critics. And, granting that the dangerous results which were pointed out did actually obtain under the gross misuse to which tuberculin was subjected, it would have absolutely no weight in the consideration of the remedy when administered properly.

Virchow said:[1] "I think that we may now with certainty say that any process that can be brought about by tuberculin can also come about without that remedy, but the course certainly often seems to be extraordinarily hastened."

Even in spite of the disastrous results caused by bad selection of cases, and improper dosage, there were a few men who could not help seeing the true value of the remedy. These began to use it cautiously, and with one accord determined that its proper administration consisted in beginning with small doses and gradually increasing as toleration was established, but always avoiding marked local reactions and general reactions entirely. Under this mode of administration, von Bardeleben, Guttmann, Renvers, Ehrlich, Petruschky, Cornet, Goetsch, Turban, Krause, and many other noted men abroad, as well as von Ruck, Whittaker, Denison, and others in America, report excellent results. It is the general experience of all those men, who have carefully and painstakingly sought to do the remedy justice, that tuberculin is a very useful remedy, that it has a specific action in tuberculous cases. Professor Petruschky[2] says: "If in its (tuberculosis) treatment we desire to attain success, we must bring to our resources all means which are available to medical science, and a prominent one of these is undoubtedly tuberculin. After nine years of trial of the remedy it is possible to arrive at a conclusion of its value. Only a comparatively small number of physicians have used and studied this remedy continually during this time, but it is significant that these have arrived at a favorable judgment of its value."

Dr. Goetsch[3] reported his experience in one hundred and seventy-five cases of pulmonary tuberculosis treated with tuberculin during the past ten years. Of the cases treated, one hundred and twenty-five, or

[1] *Berliner Klin. Wochenschrift*, 1891, p. 191.

[2] Paper before Berlin Congress; Reported in *Journal of Tuberculosis*, vol. 11, p. 62.

[3] *Deutsche Medicinische Wochenschrift*, 1901; quoted in *Journal of Tuberculosis*, vol. iii, p. 277.

seventy-one per cent., were cured. This report was made at the suggestion of Professor Koch, and to it he appended a note, in which he said: "All physicians who have had considerable experience with tuberculin treatment, and have published the same (Spengler, Turban, Petruschky, Krause, Thorner, Heron, Rembold, Baudelier), assert that if the treatment is restricted to purely tuberculous and not too far advanced cases—that is to say, non-febrile cases of pulmonary tuberculosis—the influence of the remedy is favorable without exception." Should not the testimony of these clinicians, whose experience has extended over the entire period from Koch's announcement in 1890 to the present time, outweigh the doubt expressed by the hosts of physicians who have never given the remedy a trial? Again, I repeat, *one positive result should outweigh a dozen failures.*

I have endeavored to present in a clear light the circumstances under which tuberculin, the first culture product used in the treatment of tuberculosis, was given its trial by the medical world, and I have endeavored to show why it has been held in such disrepute. Now let us make a more careful study of tuberculin itself, and those other culture products which have grown out of it.

Soon after the germ theory of disease was propounded, bacteriology became the most active branch of medicine. In the laboratories the action of germs was carefully studied. In 1883 Charrin[1] discovered that the blue color sometimes seen on wounds and dressings was due to an organism, which, when inoculated into animals, caused death by septicemia. He found also that by inoculating the animals with sterilized cultures of the same bacillus they were rendered immune to the inoculations by virulent cultures. Brieger and Frankel[2] found that the filtered culture fluid of the diphtheria bacillus, when heated to 60° or 70°, had protective properties, rendering guinea-pigs insusceptible to inoculations with diphtheria virus.

Such observations as these, many of which were made at that time, led to the conclusion that pathogenic organisms produce a certain substance during their growth which is inimical to the organisms themselves.

The observation which led to the discovery of tuberculin was as follows: Professor Koch found that when healthy guinea-pigs were injected with virulent cultures of tubercle bacilli, during the first few days the wound healed; but after two weeks nodules formed, which

[1] *Arch. Gen. de Med.*, Paris, 1882, vol. ii.

[2] *Untersuchungen ueber Ptomains*, dritte Theil., s. 85, 1886.

broke down and continued ulcerating until death. But guinea-pigs already tuberculous, when inoculated at the first showed the same small wound; however, nodules did not form, only a general induration appeared about the point of inoculation, which later became necrotic, sloughed off, and quickly healed, without the lymph glands even becoming infected. When, instead of virulent cultures, dead cultures were used in healthy guinea-pigs, a local suppuration occurred; while in tuberculous guinea-pigs, even small doses caused death; but if the cultures were much attenuated and administered very gradually, the disease, unless too far advanced, came to a standstill. From these observations, Koch concluded that tubercle bacilli, during their growth, produce a substance which has curative properties in tuberculosis. After a series of experiments he produced tuberculin, which is the culture fluid upon which bacilli have been grown, concentrated to one-tenth its original volume, and filtered.

Klebs found that tuberculin contained substances both beneficial and toxic, and by certain methods of treatment produced tuberculocidin and antiphthisin, for which he claimed the advantage of tuberculin, without its toxic working substance.

One of the most enthusiastic workers in the field of culture products is our own fellow countryman, Dr. Karl von Ruck, of Asheville, N. C. When Koch made his announcement, von Ruck hurried to Berlin, and through his friendship with Dr. Paul Guttmann had special opportunities offered him to study the new remedy. While he saw the mistakes that were being made in the administration of tuberculin, he also noted the good results that it was capable of producing.

Coming home, Dr. von Ruck began experimenting in his own laboratory, and as a result in a few years produced tuberculinum purificatum, which was made by boiling the culture fluid containing the bacilli, *in vacuo*, at a temperature of 130° F. for two or three months. By this prolonged boiling and maceration a considerable portion of the proteids from the body of the bacillus was brought into solution.

If the culture fluid contained the substance which was beneficial, it must come from the bacillus; hence the bacillus must contain it, either as secretion or excretion. Now, instead of using the culture fluid alone or in part, Koch produced a new remedy by the pulverizing of dried cultures in a mortar and mixing them in distilled water. The mixture was then thoroughly centrifuged. This was given forth in 1897 as tuberculin R. In this preparation Koch believed that he had obtained a true solution of the bacillus, hence obtained the most com-

plete remedy that could come from cultures. It was shown that this preparation was an emulsion containing not only fragments of bacilli, but entire bacilli, which were still virulent; hence the preparation was soon withdrawn from the market. However it has since been freed from this disadvantage, and used with marked success.

In 1896 Dr. von Ruck succeeded in producing a true solution of the tubercle bacillus, which he calls the watery extract of tubercle bacilli. The method of producing it is as follows:[1]

"The tubercle bacilli are filtered out of the rapidly growing and highly virulent culture. After washing with distilled water for the removal of the remains of the culture fluid, they are dried in a vacuum desicator. Next they are powdered in an agate mortar, and then extracted with sulphuric ether. This extraction removes the fats. They are again dried and powdered as before, and their further extraction takes place in sterilized distilled water over a vacuum bath, with a temperature of 120° F. The proteids becoming dissolved in the distilled water, the fluid is then decanted and filtered through porcelain, when finally the amount of proteids is determined and the preparation standardized to a certain per cent."

This is entirely free from culture fluid, and is the most refined of all the culture products, and its efficiency has proven to be superior in the hands of all who have used it.

Thus we can see a gradual evolution in the production of these culture products. First, the pure culture fluid was used—tuberculin; then a purified culture fluid—tuberculocidin and antiphthisin; then a mixture of culture fluid and proteids from the bodies of the bacilli—tuberculinum purificatum; then an emulsion of bacilli and fragments of same—tuberculin R.; and finally a pure solution of the bacilli—watery extract. That this is the end we do not know. We hope not. Yet we have in this last a product whose value cannot be questioned by any one who will give it a reasonable trial. All of these products are of value, and deserve a place in the history of the combat with tuberculosis. I have had personal experience with all of these products in treatment, except tuberculin (my experience with it being confined to making the tuberculin test), and I have been surprised that their worth has not been more generally recognized.

In what manner these culture products act is still debatable. Various theories have been offered. The original explanation of Koch that tuberculin broke down the granulation tissue surrounding the tubercles

[1] *Therapeutic Gazette*, June, 1897.

and allowed the defensive forces of the body to attack the bacilli, or by this breaking-down caused the tuberculous masses to be thrown off, was never accepted by those who placed any value upon the remedy, because they considered it absolutely essential to avoid the reactions which would cause such a result.

Landgraf,[1] who observed the disappearance of tubercles in the choroid and also on the epiglottis under the use of tuberculin, gave it as his opinion that the action of tuberculin "is not, as was maintained, an acute necrosis and throwing off nor a suppurating process, but an acute cheesy degeneration of the tuberculous granulation masses followed by their absorption."

Krause[2] says: "It is well known that tuberculin has no effect upon the actually tuberculous tissue (the tubercle with its necrotic center), but only upon the newly formed tissue, which is richly supplied with blood-vessels and surrounds the tubercle."

Biedert[3] says: "When the irritation (caused by the local reaction) is moderate, an increased cell growth takes place in the encapsulating wall of the tuberculous process. If the inflammation is more intense, marked exudation occurs, while in the stage of extreme inflammatory irritation, cell death, necrosis results." Trudeau[4] says it acts "probably by inciting the formation of fibrous tissue."

These quotations refer to tuberculin, but since all these culture products contain perhaps the same active principle, they will apply to the others likewise. My experience with the culture products would lead me to believe that they have an action which causes absorption and removal of recent tubercles; otherwise the roughened and enfeebled respiratory notes would not become normal when healing has taken place.

The many opportunities offered for studying these remedies, where the action can be watched by the naked eye, should furnish sufficient evidence to convince the most skeptical that in culture products we have remedies which are a specific in their action upon tuberculous lesions. Even the earliest reports made, those during the fated years of 1890 and 1891, are replete with such evidence. Albrant saw the complete

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[1] *Berliner Klinische Wochenschrift*, 1891, p. 286.

[2] *Zeitschrift fuer Hygiene and Infectionskrankheiten*, vol. xxxiii, 1900; translated in *Journal of Tuberculosis*, vol. ii, p. 242.

[3] *Berliner Klin. Wochenschrift*, 1891, p. 197.

[4] *Transactions of the Association of American Physicians*, 1900.

disappearance of a conjunctival tuberculosis; Landgraf[1] that of tuberculous processes of the choroid and epiglottis; Renvers[2] cured a patient whose pharynx, epiglottis, and mucous membrane over the arytenoids were covered with ulcers; Koenigshofer and Maschke[3] obtained cures in tuberculous corneal ulcerations; while it was not at all uncommon to see cases of lupus yield to its administration. The literature of recent years also bears much valuable testimony in such cases. Dr. von Ruck[4] reports many cases of laryngeal tuberculosis in which the lesions have disappeared.

Schmidt[5] insists upon the unmistakable benefit derived from tuberculin in the treatment of mild cases of laryngeal tuberculosis where surgical interference is uncalled for, and cites many cases cured by such means. Dr. Hale[6] reports a very interesting case of tuberculosis of the nose, in which the triangular cartilage was entirely gone. There was a large ulcerating surface discharging pus along the inner surface of the left ala of the nose, also ulcerations upon the uvula. The discharge showed tubercle bacilli. A complete cure was effected by the use of tuberculinum purificatum (von Ruck). During the past winter it was the writer's pleasure to see an ulceration of the left vocal cord in a patient who had lesions in both lungs heal under the use of the watery extract. While in many cases such as these healing has been observed, the great field for the culture products is in the treatment of pulmonary tuberculosis. It would be enough to make the names of the discoverers of these products immortal if their field of usefulness were limited to the cure of visible tuberculous infiltration and ulcers only, particularly those affecting the larynx, which complicate nearly one-fifth of all pulmonary cases, and which heretofore have almost baffled treatment. But the results obtained in the lung are no less brilliant, as they are observed by the ear of the trained diagnostician.

To make a fair test of culture products in pulmonary tuberculosis, one must, in the first place, be able to interpret the pathological condition by the physical signs, so as to know what is removable and what is not. Secondly, he must have some means of comparison. It is impos-

[1] *Berliner Klin. Wochenschrift*, 1891, p. 285.

[2] *Deutsche Med. Wochenschrift*, 1891, p. 512.

[3] *Deutsche Med. Wochenschrift*, 1891, p. 76.

[4] *Journal of Tuberculosis*, vol. i, p. 22, and Clinical Report from Winyah Sanitarium for the years 1899 and 1900.

[5] *Krankheiten der Oberen Luftwege*, 1898.

[6] *Journal of Tuberculosis*, vol. iii, p. 239.

sible to carry in one's mind the percussion and auscultatory signs of one case, let alone a dozen; so, if one wishes to know whether or not his cases are improving, he should make systematic examinations, say at least once a month, and record his findings upon a chart for comparison at the next examination. Thirdly, he must remember that the remedy must be used for a length of time. Slight results are often seen during the first month of treatment, and during the second the change becomes more evident. But, finally, when the recent tubercles have all disappeared, and one has to deal with dead and decaying tissue, he must not become impatient because of the time that it takes to heal such lesions.

Let us next consider whether there is any ground for claiming an advantage for culture products over the hygienic, climatic, and ordinary medical treatment of tuberculosis. To this end we will bring forth the statistics of various men who have had considerable experience in tuberculous work.

In 1891 Langenbuch and Wolff[1] reported 99 cases treated with tuberculin, and 99 without. Of the former, 33 were cured and 40 improved; of the latter, 9 were cured and 45 improved. Of tuberculin cases, 73 per cent. were improved and cured; of those treated without it, 54 per cent. were improved and cured.

Goetsch, in a recent report, referred to above, sums up his experience since 1891, as having treated 175 patients, and cured 125, or 71 per cent. The remaining 50 patients interrupted the cure from time to time, so the results were less favorable.

Heron[2] since 1890 has treated 51 cases of pulmonary tuberlosis with tuberculin. At the end of 1900, 17, or 33 1-3 per cent., had been lost sight of. Of the remaining 34, 16, or 47 per cent., were well and earning their own living. Ten of these had been discharged seven years.

Krause[3] in six years had treated 27 patients of whom 12 or 44.4 per cent. are well and 13 or 48 per cent. are improved. Denison[4] reports 196 cases treated by culture products, including all the various products from tuberculin to watery extract. His results show an apparent recovery of 34 per cent., and a marked improvement in 42 per cent. He remarks that this was not a list of easy cases, the following complications being present: "Lupus three cases, meningitis two, Bright's disease one, pyonephritis one, tuberculous kidney two,

[1] *Deutsche Med. Wochenschrift*, 1891, p. 935.

[2] Paper before London Tuberculosis Congress, 1901.

[3] Cited in Heron's paper before London Tuberculosis Congress, 1901

[4] *Journal of Tuberculosis*, vol. iii, p. 111.

glandular cases six, joint tuberculosis four, tuberculous testicle two, bladder tuberculosis three, and intestinal tuberculosis two." Of these, 49 were in the first stage; 38 second; and 109, third.

Trudeau[1] makes a comparison of the incipient cases treated at the Adirondack Sanatorium with and without tuberculin. Twenty-four cases were treated with the remedy, of which 20, or 83 per cent., were apparently cured; and 113 without, of which 82, or 72 per cent. were apparently cured—a slight percentage (11 per cent.) in favor of tuberculin. He then chooses 50 patients discharged as apparently cured with tuberculin since 1894, and 50 patients corresponding in lesions and time of treatment who were cured without tuberculin, to see the relative permanency of the cures. Three of those treated with tuberculin could not be traced; so three were dropped from the list treated without tuberculin. Of the remaining 47, 41 of the tuberculin-treated patients remained well, 1 had relapsed and was living, 4 had relapsed and were dead, and 1 had died of insanity. Of the 47 treated without tuberculin, 36 remained well, 6 had relapsed and were living, and 5 had relapsed and died. So we see 82 per cent. of those treated with tuberculin remained well as against 72 per cent. of those treated without it, a balance of 10 per cent. in tuberculin's favor; or, putting it in another way, at the end of the time considered, 68 per cent. of those treated with tuberculin remained well, and 52 per cent. of those treated without tuberculin remained well, a balance of 16 per cent. in favor of tuberculin. While the author says the cases treated with tuberculin were very carefully chosen, yet he adds in another place that "the results in the cases classed as advanced (treated with tuberculin) were proportionally somewhat more favorable." So, from this report, we may say that tuberculin does undoubtedly possess some advantages in the treatment of pulmonary tuberculosis; and since it is the permanency of the cures that is desirable, we must find in it a valuable aid in combating this great scourge.

Perhaps few men have had as much experience with culture products as Dr. von Ruck,[2] who has reported 1030 cases treated with them, with the following results: (I will insert 816 cases treated without culture products for comparison; as these were all treated in the same institution, the comparison is all the more valuable.)

[1] *Transactions of the Association of American Physicians*, 1900.

[2] *Journal of Tuberculosis*, vol. i, p. 23; Clinical Report from Winyah Sanitarium for years 1899 and 1900; and *Therapeutic Gazette*, May, 1896.

	No. of cases.	Recovered.	Improved
Without specific treatment..............	816	12.1 p. c.	31.0 p. c
Treated with Koch's tuberculin.........	379	35.5	37.5
Treated with antiphthisin and tuberculocidin............................	182	32.5	46.8
Treated with tuberculinum purificatum (von Ruck)......................	166	43.4	39.2
Treated with watery extract of tubercle bacilli (von Ruck)................	303	56.1	33.7

Now, let us take statistics of cases treated without the use of culture products.

Curschmann,[1] of Leipsig, says: "Lung sanatoria give a percentage of permanent improvement which amounts to about one-fifth of all cases treated." This is by the ordinary sanatorium method.

Stubbert's[2] report of the Loomis Sanitarium for the year ending November 1, 1899, shows 85 patients treated by ordinary sanatorium methods, of whom 14 per cent. were apparently cured, and 62 per cent. improved. Since the opening of the institution 456 patients have been treated, with the result that 22.6 per cent. have been cured and 40 per cent. improved.

Flick[3] reports 18 per cent. as cured, 10 per cent. disease arrested, and 26 per cent. very much improved.

Trudeau and Baldwin[4] report that 67 per cent. of truly incipient cases were cured, and 11 per cent. of advanced, in a material of 300 incipient and 900 advanced cases; 73.5 per cent. of incipient cases were cured in 1897 and 1898.

A report of German sanatoria[5] recently published shows, of 5986 patients treated, an apparent cure in 7.4 per cent. Then to show the permanency of results, statistics of 1878 patients are given, who have been dismissed for four years. The percentage of those able to work at the end of each year is noted. Of this number 424 patients were

[1] Address before Berlin Congress, 1899; reported in *Journal of Tuberculosis*, vol. i, p. 90.

[2] *Philadelphia Medical Journal*, Dec. 30, 1899.

[3] *Journal of Tuberculosis*, vol. iii, p. 116.

[4] *Transactions of the Association of American Physicians*, 1900; *Albany Medical Annual*, April, 1900; *The Practitioner*, February, 1899.

[5] Results of the Open Air Treatment of Consumption, Berlin, 1901.

in the first stage of the disease, 863 in the second, and 373 in the third. The results are as follows:

Patients able to work at end of	First stage. Per cent	Second stage. Per cent.	Third stage Per cent.
First year	89.1	80.3	56.5
Second year	89.1	60.7	24.1
Third year	63.7	49.2	14.3
Fourth year	44.4	16.7	0.

Among these patients the number of cures is not given; hence, since they are to be compared with results produced with culture products we will grant that all who were able to work at the end of four years were cured, which, of course, we know is too large a number. Then we have 21 per cent. cured. Counting all of the remainder, who were able to work upon dismissal as improved, we have 67 per cent.

The report of the surgeon in charge of the Army Hospital for Consumptives at Fort Bayard, N. M.,[1] shows 49 patients dismissed prior to August 6, 1900. Of these 4, or 8 per cent., are designated as cured; 11, or 22.4 per cent., as convalescent; 20, or 40 per cent., as improved.

Bowditch and Clapp,[2] of the Massachusetts State Sanitarium for Consumptives, have treated 273 cases, curing 115, or 42 per cent. In selecting these cases great care was used, 60 per cent. of applicants being rejected.

The report for the Sailors' Consumptive Hospital at Fort Stanton, N. M.,[3] to June, 1900, shows 17 discharged, of whom 4, or 23.5 per cent., were apparently cured, and 13, or 76.5 per cent., improved.

A careful comparison of these results cannot help but give one a favorable impression of the culture products, particularly of the more refined culture products, in the treatment of tuberculosis. Especially is this true of the permanency of results.

While it is difficult to draw exact conclusions from a mass of statistics as given above because of the difference in classification of what is cured and improved, and because some authors have chosen only incipient cases and others have included all stages in their report, nevertheless I will arrange them in a table so that it can be seen at a glance what is being done for the tuberculous patient both with and without the use of culture products. Those who are interested can look up the

[1] *Journal of the American Medical Association*, Oct. 20; 1900, p. 1003.

[2] *New England Magazine.*

[3] *Journal of the American Medical Association*, Oct. 20, 1900, p. 101.

references and draw their own conclusions. The table comprises 12,-569 cases in all; 1795 treated by culture products and 10,744 treated without.

CASES TREATED WITH CULTURE PRODUCTS.

	No. cases treated	Apparently cured. Per cent.	Improved. Per cent.
Langenbuch and Wolff (old tuberculin)	99	33.3	40.0
Goetsch (incipient only, Koch's tuberculin)	175	71.0	29.0
Krause (Koch's tuberculin)..............	27	44.4	48.0
Heron (Koch's tuberculin)...............	34	47.0	
Denison (Koch's tuberculin).............	57	32.0	40.0
Tuberculocidin and antiphthisin (Klebs)................... Tuberculinum purificatum (von Ruck)....................	94	33.0	40.0
Various reports (watery extract of tubercle bacilli, (von Ruck).................	45	40.0	49.0
Trudeau (incipient only, Koch's tuberculin)...........................	24	83.0	
von Ruck (Koch's Tuberculin)..........	379	35.5	37.5
Antiphthisin and tuberculocidin—Klebs:			
First stage......................	32	81.0	19.0
Second stage....................	74	35.1	56.7
Third stage......................	76	9.0	47.3
(Purified tuberculin—von Ruck)........	166	43.4	39.2
(Watery extract of tubercle bacilli—von Ruck:			
First stage......................	73	94.5	5.5
Second stage....................	117	66.6	33.3
Third stage......................	113	20.3	52.2
Various reports (watery extract of tubercle bacilli—von Ruck)...............	210	44.0	42.0

CASES TREATED WITHOUT CULTURE PRODUCTS.

	No. cases treated	Apparently cured Per cent	Improved Per cent
Langenbuch and Wolff...................	99	10.0	45.0
Trudeau, first stage......................	300	68.0	
Advanced stage..................	900	11.0	
Bowditch, Mass. State Sanitarium:			
First stage......................	66	59.0	40.0
Second stage....................	45	22.0	64.0
Third stage......................	30	23.0	63.0
Clapp, Mass. State Sanitarium:			
First stage......................	82	64.6	34.0
Second stage....................	40	15.0	45.0
Third stage......................	10		30.0
Flick..................................		18.0	36.0
Ft. Bayard Sanitarium..................	49	8.0	62.4
Ft. Stanton Sanitarium..................	17	23.5	76.5
von Ruck..............................	816	12.1	31.0

Stubbert, Liberty Sanitarium:			
First stage	163	58.0	36.8
Second stage	216	9.0	56.0
Third stage	77		4.0
German Sanatoria	5986	7.4	80.3
German Sanatoria*	1878	21.0	68.8

The total number of cases treated and number of apparent cures, both with and without the use of culture products, are set forth in the following table for comparison:

	No. cases treated	No. of cases Apparently cured.	Apparently cured Per cent
With culture products	1795	806	44.9
Without culture products	10774	1486	13.8

So much that is adverse has been written on this subject that I will add the opinions of some of the men who have tried culture products, and know their value.

Trudeau[1] says: "My experience with tuberculin treatment at the Sanitarium thus far has led me to believe that, when carefully applied, in suitable cases, it has proved apparently free from danger, and that it has seemed to have some favorable influence in bringing about healing of the lesions, probably by inciting the formation of fibrous tissue." Again:[2] "The injections, nevertheless, seem to have had a favorable influence in preventing the natural tendency of the disease toward relapses, which occur in many who recover under climatic and hygienic methods alone."

Krause[3] says: "The failures of the first tuberculin epoch are, without exception, the result of the improper methods at that time employed in the administration of the remedy. For that reason no one is justified, on the grounds of the experience of 1891, in passing adverse judgment upon the remedy. On the contrary, it is important that the remedy be extensively tried anew in accordance with the now accepted indications. For thereby entirely different results than those of 1891 will be obtained and the medical profession will be richer by one valuable remedy."

* In making up these percentages I counted all who were living and able to earn a livelihood four years after dismissal from the Sanatoria as cured, as mentioned above.

[1] *Transactions of the Association of American Physicians*, 1900.

[2] *The Practitioner*, February, 1899.

[3] *Zeitschrift fuer Hygiene und Infectionskrankheiten*, vol. xxxiii, 1900; translated in *Journal of Tuberculosis*, vol. ii, p. 255.

Denison[1] says: "Despite the charges of failure of this specific method of treatment, made by hasty and indiscriminating critics, it is coming more and more to be acknowledged by those physcians who are willing to test the matter, that there *is* a special and specific stimulation of tuberculous living tissue, which is characteristic of a healing process."

Von Ruck[2] says: "The favorable and specific action of the remedy becomes manifest not only in the general improvement with subsidence of subjective symptoms, but in a more direct manner. . . . It consists in the disappearance of tuberculous lesions accessible to sight and touch, as well as of those which we recognize through percussion aud auscultation. Tuberculous cervical, axillary, and other accessible glands that are not caseous or fibroid, disappear under its use; infiltrations in the larynx grow less and finally disappear; and infiltrations in the lungs revealed by slight percussion dulness, and by rough, harsh, or broncho-vesicular respiration, with or without circumscribed catarrh, grow perceptibly less and disappear under the treatment, without other medication. These are changes which we do not note from the application of other methods. The latter, so far as I know them, fail in directly influencing the pathological lesions, and while they are indirectly beneficial and aid in bringing about the previous condition of latency, they do not actually cure. In this view I am confirmed by the fact that while without specific medication subjective symptoms may disappear, the objective evidence continues; percussion dullness over the tuberculous areas does not clear up; râles may disappear, but the abnormal respiratory sounds persist in the parts which were and still are the seat of tubercles, and the patient still reacts to the tuberculin test; whereas in patients that have been successfully treated with the remedy under consideration (watery extract of tubercle bacilli) the physical signs of recent tuberculous processes disappeared entirely, and no reaction occurred to the tuberculin test up to the present time, even in the earliest cases treated. . . In the cases that came under treatment in the early stage I have seen or heard of no relapses yet. . . . That it produces a relative degree of immunity has been shown by the animal experiment, and clinically by the marked freedom from extension of

[1] *Journal of Tuberculosis*, vol. iii, p. 112.

[2] Clinical Report of the Winyah Sanitarium of Asheville, N. C., for years 1899 and 1900.

tuberculous processes, and from relapses of patients who are under treatment or have been discharged."

The question is often asked, "Can these products do harm?" Of course they can, the same as morphine, strychnine, or any other remedy. The results of 1890 and 1891 show that they can do harm; but it is the experience of all those who have made a careful study of the products, and given them a fair trial in practice, that they cannot do harm when administered carefully. My own experience has been very encouraging. I have made a careful study of my cases, and I have never seen the least harm done. On the contrary, my results have been most happy, and I do not believe that they could be duplicated by any other treatment.

The time has certainly arrived when the medical profession should give the culture products a fair trial. The opinions of men who have not tried these remedies, but who have drawn their conclusions entirely from the wrong use of tuberculin when it was first introduced, are to be compared with the opinions of those who know from experience, and who report the cases that have been treated and show the results obtained. Culture products have the right to demand a trial by an unbiased court wherein spurious evidence will be discarded, and only positive evidence taken. All friends of these remedies will stand by the decision.

It must be remembered, however, that the friends of culture products should not relax their efforts in other lines. It has been said by the critics of men employing these remedies that they use hygienic dietetic, and climatic treatment as well. So they do; they would be foolish if they did not. The surgeon combines all of these with his use of the knife, and it is considered praiseworthy in him. So those who recognize the value of culture products find their results are much better when their cases are properly handled, and they always endeavor to guide the entire life of their patients. It should be considered as malpractice to simply inject culture products, and leave the patient to guide his own life. With reference to this point Professor Koch is reported to have said at the Tuberculosis Congress held in London in 1901[1] that he did not wish anybody to get the idea that he himself thought there could be any antagonism between treatment by tuberculin and the outdoor treatment in or out of sanatoria. He has always insisted that the two should go on together.

A careful review of this subject, together with practical experi-

[1] Reported in *British Medical Journal*, July 27, 1901, p. 214.

ence in the use of culture products, leads me to the following conclusions:

1. Culture products *do* have a specific action upon tuberculous foci.

2. That this has not been recognized is due to the early unfortunate experience with tuberculin: (*a*) When it was used in too large and too frequent doses; (*b*) when it was employed in unsuitable cases; (*c*) when it was held responsible for all post-mortem findings.

3. The field of usefulness for culture products is where recent tubercles are found, and this is especially in incipient cases.

4. If used in advanced cases, culture products will help remove areas of recent extensions, but must not be expected to remove dead, decaying, or newly formed tissue.

5. Where culture products are used, they should be reënforced by every means at command. Every phase of the patient's health should be cared for, and the proper hygienic and dietetic measures prescribed.

6. Where the case is managed properly and culture products are used, the proportion of cures is greater than when culture products are not used.

7. Culture products produce an immunity, which protects the patient from relapses; hence, make a permanent cure more often than hygienic and climatic treatment alone, which fact of itself should be enough to warrant their use in all suitable cases.

ORIGINAL TRANSLATIONS.

PULMONARY TUBERCULOSIS AND SANATORIA.*

BY DR. AUFRECHT, MAGDEBURG, PHYSICIAN-IN-CHIEF TO THE INTERNAL DIVISION OF THE ALTSTADTER HOSPITAL.

My subject was not suggested to me through the highly startling communication of Koch[1] to the recent British Congress of Tuberculosis. On the contrary the title of my paper was announced as long ago as last spring; but I cannot refrain, while discussing my own subject, to express my opinion of Koch's doctrine in the consciousness that my right to do so has been earned through long continued experimental, clinical and anatomical investigations.

Koch, through his latest experiments, has brought forward evidence that human tuberculosis is not communicable to cattle. He has made injections of the sputum of consumptives and cultures of the bacilli—subcutaneous, intra-abdominal and intravenous—and he has also caused the animals to inhale these products; but was never able to induce tuberculosis by these procedures. After the experiment-animals had been slaughtered, the internal organs were invariably found to be free from tuberculosis. The points at which the subcutaneous injections were made were the seats of small abscesses in which were found a few tubercle bacilli—the same condition in fact as that which follows the injection of dead bacilli.

On the other hand bacilli from tuberculous cattle transmitted the disease to healthy cattle with invariable success.

Pigs, when fed with the products of bovine tuberculosis, exhibited the most severe lesions of the disease within a period of 3½ months. When these animals were fed with human tuberculous sputum, they developed no trace of the affection beyond a small nodule here and there in the cervical lymphatics, and, in a solitary animal, a few gray tubercles in the lungs.

Koch maintains further that, as the bacillus of human tuberculosis is not pathogenic to animals, the bacillus of bovine tuberculosis cannot produce the disease in mankind. Were the contrary true, the

*Translated for The Journal of Tuberculosis, from the *Berliner Klinische Wochenschrift*, Oct. 21 and 28, 1901.

[1] Koch, R. The Combating of Tuberculosis in the Light of the Experience Which Has Been Gained in the Successful Combating of Other Infectious Diseases. *The British Congress of Tuberculosis*. London, 1901.

ingestion of milk and butter which can and does often contain virulent tubercle bacilli would produce intestinal tuberculosis, especially in children. As a matter of fact, this lesion occurs in the latter with great infrequency, and when present is due most probably to swallowing the bacilli of human tuberculosis.

If a diagnosis of intestinal tuberculosis is to be placed beyond doubt, the bacilli must be obtained in pure culture, and an attempt made to inoculate cattle with them. As far as investigations have been carried along these lines, they do not justify the assumption that bovine tuberculosis occurs in mankind.

It therefore appears that the question of infection of human beings through the milk, butter and meat of tuberculous cattle is of no greater practical significance than that of hereditary transmission; and that in consequence it is not advisable to institute measures based upon the contrary supposition.

I must now express a few scruples, based on my personal experimental studies, against Koch's deductions. Since the publication of my investigations upon the experimental production of tuberculosis in rabbits in 1881[1], I have carried out a considerable number of additional experiments, and have been able thereby to establish the fact that tuberculous substances proceeding from cows will invariably set up miliary tuberculosis; while corresponding material from mankind sometimes fails to transmit the disease.

When an animal so sensitive to the virus of tuberculosis as the rabbit sometimes proves refractory to the inoculation of products of the disease in mankind, it becomes very evident that the bacillus of the latter affection is less virulent than that of bovine tuberculosis. What is true of the latter does not yet hold good for the former; or in other words, the less virulent tubercle bacillus of mankind need not engender bovine tuberculosis in cattle, and the much more virulent bacillus of bovine tuberculosis may produce the disease in man.

Koch himself, however, through his own statements, gives support to such a comprehension of the matter. As already mentioned he transmitted human tuberculosis to swine to a very slight degree. As he states expressly that all other sources of infection may be regarded as out of the question, the bacillus of human tuberculosis was pathogenic here, but much less extensively and intensely so than the germ of bovine tuberculosis. Does not this assert that the first named microörganism is much less virulent than the latter?

When the infrequency of occurrence of intestinal tuberculosis in

[1] Aufrecht, *Pathologische Mittheilungen*, Heft I. Magdeburg, 1881.

children is adduced as proof of the absence of pathogenicity of the bacillus of bovine tuberculosis for mankind, a territory is invaded which is at present too little known to serve as a basis for deductions. Is it necessary that the bacillus should cause a local lesion in the intestine when it has qualities which enable it to infect the organism at large? Years ago I expressed a supposition[1] that the intestinal canal furnished the port of entry in acute miliary tuberculosis without the production of local infection. This supposition I can now support in a manner not to be underrated by my numerous experiments of feeding with the products of tuberculous cattle. In not a single case did there develop a lesion of the intestinal mucosa. But beneath the fully intact membrane, i. e., in the mucous tissue at the site of the normal lymph follicles, exceptionally numerous caseous nodules were found, containing bacilli. Very often these tubercles were closely packed in the long vermiform appendix.

It is therefore shown with absolute certainty that the highly virulent bacillus of bovine tuberculosis can penetrate into the tissues of the rabbit through the mucous membrane, without causing a local lesion. We are not justified, however, in the assumption that this fact applies as well to the intestine of the child; but neither is there sanction for the claim that the infrequency of intestinal tuberculosis in the child is evidence that the bacillus of bovine tuberculosis may not penetrate the intestine of the latter.

From my own experience I think we may at least infer that it is not yet advisable to reject the quondam belief that bovine tuberculosis is transmissible to mankind. But, however this question may be settled eventually, it will not affect the subsequent portion of the present paper.

Even before the discovery of the tubercle bacillus by Koch, I had become convinced from my own studies that the tubercle contained specific microörganisms. But I was unable to agree with the view that pulmonary tuberculosis could arise from inhalation of the bacillus. Clinical observation compelled me to deny the existence of such a mode of origin for this affection, and to exclude the possibility that the latter could arise from the action of the bacillus upon the healthy lung tissue.[2] Consequently, upon the basis of the hitherto valid assumption, that pulmonary tuberculosis begins with an affection of the terminal ramifica-

[1] *Pathologische Mittheilungen*, Heft. IV. p. 56. Die Lungenschwindsucht. Magdeburg, 1887.

[2] Cf. *Pathologische Mittheilungen.* Heft IV. Magdeburg, 1887 and *Zur Verhuetung und Heilung der chronischen Lungentuberculose,* Wien: Holder. 1898.

tions of the air-passages, I must conclude that some other affection of the lungs precedes the deposit of tubercle bacilli.

In the meantime further histological investigation of the initial alterations in the apices of tuberculous lungs has shown that the earlier view in regard to the initial anatomical alterations expressed above is erroneous. My recent studies have readily shown—and anyone at all familiar with the use of the microscope may satisfy himself on this point[1]—that the changes in the lung tissue which announce the debut of pulmonary tuberculosis have their inception in the small blood-vessels, the walls of which undergo an extraordinary thickening from cell-proliferation, while the lumen is for the most part effaced by thrombosis. As a result the section of lung tissue supplied by the affected arteries is deprived of its nutriment, as in the case of an infarct. In this manner a great number of characteristic foci, having an acinous arrangement, are produced; the microscope showing that each acinus is a cluster of individual berries of uniform size. Between the acini are found areas of normal lung-parenchyma. (The more intimate histological changes have been described in a previous paper).

The foregoing structural changes give us an entirely new, anatomical substratum for pulmonary consumption, which is bound to lead to a complete reform in the doctrine of this affection.

The next task was to determine the relationship of the tubercle bacillus, universally present in this affection, to the exquisite type of vascular disease just described. With this end in view I first began some experiments upon rabbits. Unexpectedly I encountered histological changes in the small blood-vessels of the lungs, identical with those already described in mankind. In the vicinity of individual cheesy foci the vascular walls were notably thickened, and even transformed into a deposit of granulation-tissue.

My conclusions drawn from the investigation of human tuberculosis were now shown to be justified. A vascular affection in foci having an acinous distribution, precedes the tuberculous stage of the process. When tubercle bacilli are injected into a vein of the rabbit's ear and thence reach the pulmonary circulation, the blood-vessel is naturally the first structure to suffer. Later the formation of acinous foci occurs just as in man.

If, however, the bacilli in the circulation cause an affection of the vascular wall, sufficient to convert the latter into granulation-tissue, the

[1] Aufrecht; *Die Ursache und der oertliche Beginn der Lungenschwindsucht,* Wien. bei Hölder, 1900.

bacteria should be demonstrable in this region so attacked; and their activity should be evidenced by something more than caseation. This inference became a fact. In vessels thus altered the application of the well-known double stain revealed the presence of bacilli in abundance, both in the human and experimental tuberculosis. In the former the demonstration was most successful in cases pursuing a subacute course, the lungs alone being involved.

In what manner do the bacilli reach the pulmonary vessels in cases in which the lungs alone are infected? Inhalation according to my anatomical findings can be excluded with even more certainty than before, when my only evidence was clinical. Hardly anyone would assume that the bacilli penetrate the healthy lung tissue to reach the vessels without leaving some anatomical alteration, especially as writers are almost unanimous in their belief that the bacilli are able to cause initial lesions in the lung tissue.

My guiding star to illuminate the route by which the bacillus must pass from without to reach the pulmonary vessels was the fact of the very frequent occurrence in the human body of no other tuberculous lesions beyond caseous lymph-nodes containing bacilli. The latter may remain therein for years, even for decades without giving rise to tuberculosis. They may also cause the disease but in a self-limited form, the original danger still persisting. My most striking case of this sort, I have but recently seen: A girl, aged 19 years, died of volvulus, due in turn to numerous adhesions between the intestines which produced strangulation in the latter. I found in the mesentery of this patient a cheesy gland, containing bacilli; the caseation of the gland, which was as large as a pigeon's egg, was complete, and there was absolutely no other tuberculous lesion within the body. The history of this case disclosed the fact that at the age of four years the patient had experienced an attack of inflammation within the abdomen which terminated in recovery only after a copious discharge of pus through the navel. Everything here points to the probability of a tuberculous peritonitis, and without doubt the large cheesy lymph-node dates from that period.

My observations, which agree with those of other authors in regard to the frequent occurrence of isolated glandular tuberculosis, lead me (with the supposition that pulmonary tuberculosis is a disease of the blood-vessels, depending upon the penetration into the latter of the bacilli) to the conclusion that the bacilli reach the vessels from the bronchial glands alone. Why should not such a transfer occur from these glands to the pulmonary arteries or their branches?

The finding of circumscribed, recent, miliary tuberculosis of the

lungs in children in association with a cheesy gland in the hilum in close relationship with the affected area, makes such an assumption especially cogent. But the subject is no longer one of bare assumption with me. Guided by my deductions, I caused the assistant physician here, Dr. Goerdeler, to undertake appropriate researches into this problem. The very first experiments were rewarded by a striking degree of success. Thus far he has investigated three cases of acute, general, miliary tuberculosis in the following fashion: After removing the lungs and heart in toto, he next laid open the pulmonary arteries and veins as well as their branches; and wherever he found lymph-nodes firmly adherent to the walls, he cut out such portions, which after suitable hardening and embedding in paraffin, were cut into transverse sections with the microtome. Each section passed through both lymph-node and vascular wall. Proceeding thus he was able to supply clear proof that bacilli from the lymph-node had passed into the substance of the vascular wall without injury to the latter. Both arterial and venous twigs were thus studded with bacilli as far as the inner surface. One preparation showed a bacillus in an endothelial cell.

In those cases of exclusively pulmonary tuberculosis, in which the proofs are forthcoming that a gland in the hilum can dispatch tubercle bacilli through the wall of an arterial twig as far as the lumen, we have plainly a faultless explanation of the method by which the bacilli are able to produce an affection of the finer blood-vessels with subsequent formation of an acinous focus; and if a vein is entered by the bacillus instead of an artery we have an explanation of the mode of origin of a general, miliary tuberculosis. Dr. Goerdeler will make a thorough report of his investigations after a more extended observation-period. However, we may already claim from what we know thus far, that the mediastinal and mesenteric glands are the intermediaries through which the tubercle bacillus is propagated to the various organs of the body. The route to the parenchyma of organs is exclusively the blood-vessels. The serous membranes are probably attacked through the propagation of the bacilli along the lymphatic vessels to the serous sacs, but I am not yet in position to demonstrate the certainty of this claim.

It is almost self evident that tubercle bacilli which enter the body after birth can do so only by penetration of the mucous membranes, from which in turn they are carried to the lymph-nodes, and chiefly to the mediastinal glands. A considerable number of observations now testify to the truth of this generalization.

Certain authors have shown that tubercles and tubercle-bacilli occur in the tonsils, and in cases in which the assumption will not hold that the patient is self-infected from his own tuberculous sputum. I myself have seen in the tonsils of a child six months old, a caseous focus visible to the naked eye, and have convinced myself that the chain of cervical lymph-nodes was likewise caeous as far as the hilum of the lung. Death occurred in this case from general miliary tuberculosis; the tuberculosis of the tonsils is not to be regarded, therefore, as secondary to pulmonary localization, but solely as the site of entry of the bacillus.

It is probable that the exciting cause of tuberculosis finds its way into the tonsils and thence into the lymph-nodes in early childhood, where it may remain latent for long periods (Weigert).

The influence of an infectious disease, or of puberty may lead to a mobilization of the bacillus, which may then traverse the wall of some vessel to which the lymph-node adheres as a result of some past adenitis, and in this way gain the circulation. This penetration of the vascular wall by the bacillus could not occur without previous adhesion to the gland.

So far I may say, supporting myself step by step with facts, that the sole route thus definitely demonstrated, for the entrance of the bacillus from the external world into the lungs may be described as follows:—

1. The tonsils are to be regarded as an undoubted port of entry for the bacillus.

2. The tubercle bacillus is propagated from the tonsils along the cervical lymph-nodes to the mediastinal glands.

3. When mediastinal glands containing bacilli adhere to the pulmonary artery or to one of its larger branches, the bacillus may pass through the intact vascular wall into the pulmonary circulation, and then finds in the pulmonary apex favorable conditions for lesion of the wall of the finer vessels with subsequent production of foci.

That the lungs show such a high percentage of severe and fatal disease as a result of the presence of the bacillus in the pulmonary circulation is not due alone to the presence of the tuberculous vascular focus. It is a very rare event for the lungs to be so flooded with tubercle bacilli that they become studded throughout with acinous foci of disease, sufficient in themselves to cause death. Much more frequently do we find small, healed apex-infiltrations, which show sufficiently well that the organism possesses powerful aids in rendering the bacillus harmless, even after it has penetrated into the lungs. If we

bear in mind that peritoneal tuberculosis often heals without leaving a trace of its presence, we may regard it as possible that the same result may occur in the lungs, especially in the lower lobes.

The fact that the apex of the lung is almost invariably the first seat of the disease in chronic tuberculosis is probably explicable through the penetration of individual bacilli into the pulmonary artery from which they can most readily attack the apex, for the reason that the rest of the lung can exert a better defense. A circumstance which favors this theory is the following: As the blood is propelled to the apex by the left ventricle the inspiratory expansion of the chest coöperates less satisfactorily than is the case with the rest of the lung. Distention from coughing, running, etc., also occurs with more readiness in the apex. Coughing is an explosive removal of the air at hand in the bronchial ramifications, the glottis being closed at first, while the air is forced out by the combined action of the diaphragm and intercostal muscles. But when the force is first applied, the glottis then being closed, a part of the air in the bronchial passages must be sent backwards into the apices, for these are bounded only by soft tissues which can exert no active explosive force. The same mechanism is found in certain trades, such as those of glass-blowers, players on wind instruments, etc., in whom the air which cannot escape from the lungs is forced back toward the apices. Forced breathing is also a disadvantage to the apices. During running, dancing, mountain-climbing, bicycling, etc., the auxiliary muscles of respiration (scalenus, sternocleido-mastoid) come into use, and act in a direction contrary to that of the diaphragm and intercostal muscles, causing a distention of the apical tissue as well as of the vessels of the latter.

The greatest danger to a patient with the small pulmonary foci caused by the action of the bacilli upon the blood-vessels lies in the possibility of inflammation of the lung parenchyma around and between these primary lesions. The "disposition to phthisis" probably consists in a proneness to develop these secondary inflammatory changes. This pneumonic alteration is the element upon which depends the breakdown of the lung tissue, and doubtless comprises everything which comes under the head of etiology aside from the original bacillary causation. At least this hypothesis alone can explain why one patient develops a cavity, another fibrous consolidation involving perhaps an entire lobe, while a third case does not go beyond the formation of the original vascular lesions, the existence of which is revealed only by autopsy after death due to some other malady.

The chief task of our therapy should lie in the direction of pre-

venting and antagonizing the inflammatory process which may supervene around the primary vascular lesions. This distinction between primary and consecutive lesions will alone enable us to understand the course of the disease, and the sphere of utility of our therapeutic procedures.

What physician has failed to witness the retrogression of extensive consolidations despite the demonstration of bacilli? What pathologist has failed to see upon autopsy extensive, chronic, fibrous pneumonia investing a small cheesy focus? Pneumonic consolidation must have produced the chronic pneumonia. In many cases it unfortunately comes about that this pneumonic focus (which represents an exudate and to a less degree a haemorrhage from the blood-vessels) leads to the destruction of the supporting framework of the lung-tissue through the caseation and softening which results from the accumulation of bacilli. It is easy to convince one's self in studying sections of these pneumonic consolidations that in the areas most recently involved the alveoli contain merely swollen alveolar epithelium and blood, bacilli being absent; while in the older lesions bacilli are found between the cells which fill the alveoli, and the oldest of all consist of an amphorous mass of these microörganisms.

In addition to the degrees of predisposition of these secondary inflammatory changes another factor must be reckoned with as a proximal cause of the complicating pneumonia. The much mentioned *mixed infection* I do not indeed look upon as such a factor. This condition becomes a reality only when individual forms of pneumonia develop independently as a result of the coincident or subsequent penetration of the blood-vessels by the tubercle bacillus, or when a section of the lung tissue which has already broken down becomes infected secondarily.

The factor to which I refer is rather a purely toxic cause. Any one who has had opportunity (as in the early days of the use of tuberculin) to see as a result of the administration of large doses of this remedy the supervention of extensive pneumonia with caseation of the exudate, should be convinced that this inflammation was brought about by the toxic substances in the tuberculin. Should not, therefore the bacilli in the primary vascular foci in the apices be able likewise to produce toxins which cause inflammation in the surrounding parenchyma?

The essential results of my investigations may now be stated in terms of both etiology and pathologic anatomy as follows:—

The fear of infection as a result of inhalation of the tubercle

bacillus is unfounded and unnecessary; for the bacillus does not arrive within the lung tissue through penetration of the mucous membrane of the respiratory tract. On the contrary it is taken by the mucosa of the digestive tract and especially by the tonsil—mostly in childhood—and borne through the lymph-nodes to the blood.

Virchow's *tubercle* and *caseous pneumonia* retain their scientific foundation as two entirely different anatomical processes, although the former as far as it represents typical pulmonary tuberculosis[1] is not a nodular formation of cellular nature, but a terminal vascular focus due to thickening of the vessel-wall as a result of the penetration of bacilli; while caseous pneumonia does not become caseous until the bacilli have escaped from the vascular foci into the pneumonic exudate.

In regard to our therapeutic procedures I must note before all that the same obscurity has prevailed in this territory; because hitherto the complicating pneumonic process has not been duly considered in its relationship to the destruction of lung tissue. One authority would cure tuberculosis by antibacillary measures, another by hygienic regimen. The former states that hygiene cannot destroy the bacillus; the latter maintains that experience has sufficiently demonstrated the fact of the curability of phthisis through hygienic resources. Both are right. It is unfortunate that the representatives of the antibacillary therapy have thus far accomplished so little, for even they themselves must admit that specific remedies do not destroy the bacillus.

The representatives of hygienic measures, however, are just as little able to accomplish anything against the bacillus and its penetration through the vessel-wall; but they can do a very great deal toward the prevention and cure of the consecutive pneumonic consolidation and are thus able to ward off the breaking down of lung tissue or in other words, phthisis. The primary vascular foci may persist without danger to life (as shown by autopsies) by reason of the small number in which they exist in chronic apex-tuberculosis.

We must therefore hail the sanatorium-movement as a fortunate advance in medicine, because it offers to that wide stratum of humanity in which tuberculosis so commonly occurs, a possibility of a sojourn

[1] If tuberculous material is introduced into the subcutaneous tissues of an experiment animal (rabbit) in the neighborhood of a primary caseous focus secondary miliary tubercles arise which consist only of an increase of cells in the connective tissue, permeated by tubercle bacilli, just as the tubercles which appear beneath the serosa in intestinal ulceration are nothing but accumulations of cells in the lumen and walls of the lymph-vessels. It is worth noting that the area of these secondary tubercles is always of small extent.

under hygienic conditions sufficiently long to fortify the organism and likewise to secure a retrogression of the pneumonic processes which may be present.

That such sanatoria have been established throughout Germany without much regard to climatic conditions appears to me to be justifiable throughout; and I am of the opinion that the results will not be less satisfactory than those in southern health-resorts, so long as the physician in charge proceeds upon correct principles. As long ago as 1887[1] I expressed the opinion: "If we had a suitably arranged sanatorium in the Harz, protected as much as possible by nature, I would have no scruples against sending patients thither for the winter who for any reason were unable to leave their homes."

To obtain favorable results in sanatoria it is however requisite before all to refer the patient thither in the initial stage of the disease. The fulfilment of this condition involves numerous difficulties. The first is that the patient seldom comes to consultation in the initial stage of the malady. The inception of the disease in the apex passes without notice.

If ever the results of anatomical and experimental investigation can be brought in full harmony with clinical observation it will be through the views on the pathogeny of the disease which we have enunciated in the present paper.

The foci of the disease do not originate in the final ramifications of the bronchi but in the finer twigs of the pulmonary artery. The establishment of these lesions, however, is accompanied neither by fever nor by cough; and the patients see no occasion to consult a physician. At this period hemoptysis is the earliest subjective symptom referable to the lungs.

If the parenchyma between these foci undergoes consolidation, an occasion soon arises for an objective investigation. Patients with such foci—usually individuals between the ages of 15 and 25—often complain of symptoms which proceed from anaemia.

It would be a great error to omit an investigation of the lungs because cough is absent. The statement found in the majority of textbooks, that cough is one of the earliest symptoms of phthisis certainly rests upon an error.

Cough occurs often enough as an intercurrent phenomenon, and I am of opinion that the presence of the vascular foci predisposes strongly to attacks of bronchial catarrh, which if long persistent may lead to pneumonic alterations in the vicinity of these primary lesions.

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[1] *Pathologische Mittheilungen*, Heft IV. p. 115. Magdeburg, 1887.

This would be brought about by the extension of the catarrhal process to the finer bronchi; which in turn would be a consequence of the distention of the lung tissue already described as a natural result of coughing. These bronchial catarrhs occurring early in the disease, have, when neglected, a great bearing upon its subsequent course.

If a patient, hitherto free from ailments, comes to the medical man for the first time with a bronchial catarrh, it is natural to look upon the latter as a primary manifestation. But whoever examines a patient thoroughly will frequently be convinced that objective symptoms are at hand in cases of this sort and that they antedate the cough. Auscultation and percussion may reveal a low position of one clavicle (that is, the bone is either horizontally placed, or the acromial end is the lower); while the resonance is more hollow, higher or at times duller to percussion. The resonance may become deeper and more full during and at the close of inspiration; (in the normal apex it should be more hollow and higher). Gentle, weakened, and even cogwheel breathing may be present.

The foregoing signs frequently occur in youthful, anaemic individuals; and when all or the more important of them occur together—the lower lobes and heart being fully normal—we have sufficient evidence for the diagnosis of tuberculous infiltration of the apex. These symptoms are present long before cough occurs; and with defective protection and bad weather a bronchial catarrh, as already mentioned, may be associated with the apical lesions, but may disappear completely after appropriate treatment, to return perhaps several years later.

In case results that are demonstrable by objective examination only, are present in the apices, the prospect for recovery is very favorable. Unfortunately most patients are disinclined at this stage of their disease to subject themselves to months of treatment. This statement applies with the same truth to people in all walks of life. They do not feel sufficiently ill to renounce all their activities, and they base their refusal to obey the physician's mandate upon their good general condition. It is only after a harassing cough has developed, or tubercle bacilli have been found in the sputum that the danger is realized, and a strong inclination develops toward radical efforts at recovery.

In regard to the demonstration of bacilli, what has been said of cough as a symptom applies here with even more force. Whoever makes a diagnosis of tuberculosis only after the appearance of bacilli in the sputum, often comes to this assurance at a late period of the disease. Nevertheless we must always investigate the sputum in all sus-

picious cases; for under these circumstances doubt often becomes certainty.

It would be unjust to regard as suitable for sanitarium-treatment only cases of the incipient type just outlined. Recovery is possible even after further pathological changes have taken place in the lungs, after months of sojourn in a sanitarium. Dull resonance on percussion with a slight tympanitic quality extending to the second rib; with fine or medium moist râles, speaks for the existence of a small cavity; but when there is no striking degree of emaciation, no evidence of dyspnoea after slowly climbing stairs and also after speaking (the latter symptom is readily overlooked); when there is no elevation of the pulse-rate while patient is at rest, the patient may be admitted into a sanatorium. The significance of night-sweats and past hemoptysis is still less in regard to prognosis. Only in the late stages of phthisis do the former become resistant to treatment of every kind; while hemoptysis, being an affair of the remote past, should be judged only by the objective conditions which have remained behind.

On the other hand febrile temperatures should exclude from the sanatoria, although this prohibition does not imply that such cases may not recover. The objective findings, or the extension of the infiltration are more of a criterion of severity than the fever, which may finally subside. The actual reason for rejecting febrile cases is found in the expediency—for the time being—of restricting the sanatoria to patients with the best prospects for recovery; for at the present time the sanatorium-accommodations are too limited for even this favorable class of cases. Furthermore, the arrangement of the sanatoria to-day, is such that bedfast patients—and all febrile cases should belong to this category—can be cared for only in a very limited degree. The firmness involved in rejecting for sanatorium-treatment consumptive patients who are in need of care, is best known to those who are detailed to conduct the examinations for a great body like the Magdeburg Union. It will become necessary to find ways and means to evade the inhuman refusal of sanatorium-privileges to bread-winners; for such a refusal is tantamount in the patient's mind to a death sentence, although this is not necessarily the truth. Lung-hospitals should be erected in the vicinity of the sanatoria.

Is recovery from pulmonary tuberculosis possible through the sanatorium, or better, through hygienic management? Neither a simple *no*, nor *yes* will answer this question. The pneumonic consolidation which appears about the vascular foci, however extensive—even with participation of an entire lobe or more—can undergo complete

recovery through timely hygienic management; but the tuberculous, vascular foci remain encapsulated by a fibrous consolidation, and after a long interval may lead once more to inflammatory phenomena, provided suitable causal factors are at hand. As a result the patient with the most pronouced cure is exposed to the danger of relapse for a long period, and this peril can be averted only by living under hygienically favorable conditions. This is a hard task for the patient just released from the sanatorium. His sphere of existence is not of the sort calculated to avert relapses. Many of these patients have occupations exactly calculated to favor relapse.

In this connection we must first see clearly that a relapse in chronic tuberculosis does not signify a new infection with bacilli; as the representatives of the inhalation-theory are forced to assume, but a renewed, more or less diffuse inflammation of the parenchyma of the lung in the vicinity of the tuberculous vascular foci originally present, the existence of which involves the possibility of the passage of the bacillus into the pneumonic exudate.

As contributory causes for the appearance of an inflammation of this sort, whether a first attack or relapse, may be enumerated a series of factors only too frequently occurring in combination. These comprise overexertion, in connection with either labor or sport; drenching of all the garments or of the foot-covering alone; frequent passage from hot rooms into the cold, especially when over-heated; sojourn in dusty and poorly ventilated rooms; and excesses in alcoholics, the last named being readily associated with any one of the preceding elements.

The effect of the foregoing factors is either a hyperaemia of the lung-tissue or a catarrhal irritation of the bronchial mucosa. Hereupon the parenchyma may become inflamed.

Mindful of the etiological elements which underlie the relapses of this disease, we must endeavor before all to ward off such dangers to the recently discharged, as hard labor, extremes of weather and frequent passage from hot rooms to cold atmosphere.

Only when the head of a large factory or other enterprise is informed as to these details—and this has not yet happened—will he be able to accomplish something positive. The number of individuals employed in the trades is so great that the individual pulmonary cases, especially those which have been cured or benefited in sanatoria may be favored as far as possible by assignment to the light duties of inspector, office-assistant and the like, in place of their original work as molders, machinists, etc., etc.

Care must be taken that these cured or improved patients do not

undo on Sundays what has been done for them during the week. They must forego dancing, excursions, attendance at meetings held in close quarters with poor ventilation, etc.

Another recommendation often made to pulmonary victims for the betterment of their health should in this connection be correctly judged. One often hears advice imparted that such individuals should apply themselves to agricultural pursuits. The idea which underlies this recommendation is certainly justifiable; for a life of this sort insures the presence of plenty of pure air. If all other conditions of rural life were equally favorable, if the patient were protected from extremes of weather, if his residence was arranged to the best advantage, the country would certainly be superior to the town. But when a farm-hand is exposed to all fluctuations in the weather, when he must occupy a very small room which perhaps must be shared with others, his surroundings are worse than those of the town-employee, if the latter can but have an hour or so daily in the open air when the weather is favorable.

The greatest success of the sanatoria will be seen in the cases of officials of all kinds and of the better situated, independent patients whom I would refer likewise to these institutions if there was room to receive them; because people from these classes are so situated that after their discharge following successful treatment they are better able, from that point of view which we have enunciated, to maintain their improved state indefinitely.

THE TREATMENT OF TUBERCULOSIS OF THE EPIDIDYMIS AND TESTICLE BY LIGATURE AND DIVISION OF THE SPERMATIC CORD.*

BY DR. MAUCLAIRE, OF PARIS.

[Concluded from page 45]

ATROPHY OF THE TESTICLE BY TORSION OF THE VASCULAR PEDICLE.

Torsion of the vascular pedicle of certain of the viscera has been followed by atrophy and necrosis respectively. As applied to the epididymis and testicle, the principle of torsion of the cord has been studied in animals by Chauveau[17] who finds that atrophic degeneration follows this operation when done subcutaneously. Torsion arrests the arterial circulation of the testicle, and eight or ten turns are sufficient to rupture the cord. Gangrene of the testicle may be produced by torsion, if the blood is first rendered septic; hence the state of the blood plays an extensive rôle when the circulation of an organ is suddenly shut off.

* Translated for the *Journal of Tuberculosis*.

When gangrene does not occur after torsion, etc., histologic examination shows that the testicle has undergone atrophy, while it has at the same time become grafted to its surrounding tunics. In the human subject in which torsion has been performed, the testicle having been left in place, atrophy has rapidly resulted. Moreover, cases of spontaneous gangrene have often been placed on record; this accident is probably due to orchitis, whether infectious or tuberculous, in which torsion or infectious thrombosis of the spermatic vessels has occurred.

Our patients suffered for the most part from pulmonary lesions. and therefore it was feared that torsion, however, slight, might provoke intense pains ending in gangrene of the testicle. Such a termination has occurred, doubtless by reason of a septic condition of the blood at the time of operation.

In one case we crushed a cord with large sequestrum forceps and we have often performed this operation between ligatures to avert the likelihood of haematoma. Longuet informs us that angeiotripsy has been employed upon the cord. He has reported one case in which this operation was followed by considerable haemorrhage and advises the addition of a safety ligature.

GENERAL CONCLUSIONS.

In all records of ligatures, whether physiological or pathological, in which all the elements of the cord were concerned it is necessary to make a distinction, as follows:—In some cases the ligature was performed aseptically, while in others it was septic and infected the afferent and efferent vessels of the testicle. This distinction has not always been made, which accounts partly for the great diversity in the results obtained. New experimental researches will be required to resolve certain questions.

Ligature of the excretory duct of a gland having an external secretion causes atrophy of that gland; but for the most part ligature of the vas deferens has not led to atrophy of the testicle, which is a gland having both an external and internal secretion. Alessandri, however, finds that ligation of the vas deferens does have a tendency to induce atrophy of the testicle.

In tuberculous epididymitis, the author has never attempted isolated division of the vas deferens.

Ligature of the arteries of a healthy organ produces atrophy of the latter, but arterial ligature, practiced for the purpose of determining atrophy of organs attacked by tumors, benign or malignant, has not yielded very satisfactory results.

When the testicle is healthy, ligature of the spermatic artery causes atrophy of the testicle.

Harvey and Maunoir obtained results from this same ligature in "sarcocele"; but under this term very different lesions have been implied. In tuberculosis of the epididymis we have not yet practiced the *isolated* ligature of the spermatic artery. Upon the only occasion when we sought to perform this operation, the artery could not be found and distinguished from the veins.

Ligature of the veins of a healthy organ produces little or no atrophy of the latter. Ligature of the veins of the cord does not produce atrophy in a sound testicle. In tuberculosis we have sought to imitate Bier's method of venous stasis by ligature. The immediate result was almost negative in one case of suppurative tuberculosis of the epididymis. Eventually, however, the fistula closed and the tuberculous process appeared to be extinguished.

Division of the nerves of a healthy organ causes atrophy of the latter.

Division of the spermatic nerves has generally resulted in atrophy of the testicle. We have never practiced *isolated* section of the nerves in tuberculosis of the epididymis.

Ligature of the arteries and veins of a healthy organ causes atrophy of the latter.

Ligature of the spermatic arteries and veins produces atrophy of the sound testicle. The same result follows this ligature in tuberculosis of the epididymis and testicle. If suppuration does not coëxist, atrophy occurs rapidly, and there remains a fibro-glandular, or fibro-exglandular nodule, small, but hard and free from tenderness on pressure, giving the patient the illusion of a testicle. If the tuberculosis is suppurative, curettage, exposure to the air and centripetal cauterization with the fine point of the Paquelin, end by giving the patient —after a prolonged interval of suppuration—a fibrous nodule which satisfies him in his delight at having escaped castration. If a scrotal fistula prolongs the period of suppuration, it is, perhaps for the reason that grafting does not readily occur under these conditions.

We have never but once observed necrobiosis or gangrene of the testicle after ligature of all the elements of the cord. The patient in this case was an aged individual. Many authors and experimenters have looked upon such a termination as inevitable after total ligation of the cord.

We have crushed the cord with forceps but have never dared to

practice torsion. The latter procedure applied to the vascular pedicle of a healthy organ, will produce atrophy.

Our method of ligation and section of the cord, partial or total, is still incomplete, and we publish only immediate results of recent cases. The end in view has been:—1, to cause the atrophy of the tuberculous epididymis with the conservation of a "testiculiform" fibrous nodule; 2, to avoid the propagation of tuberculosis to the other testicle, which is seen in cases of purely external tuberculosis; and 3, to cause the retrogression of preëxisting lesions.

Generally speaking the various interventions to be described led to atrophy of the testicle in the majority of cases.

In certain cases in which the fistula persisted after the operation, we did not believe that necrobiosis had necessarily occurred, judging by the seat of the fistula and nature of the discharge. In some cases nodules of the tuberculous epididymis were eliminated.

As operative complications we have noted the presence of late haematoma which suppurated, and of temporary fistulae through which were eliminated nodules of tuberculous epididymis or sphacelated connective tissue.

Of all the methods for producing atrophy, that which has appeared to us to yield the best results is section of all the elements of the cord save the vas deferens, deferential artery and the veins which accompany the latter.

Finally our observations refer only to adults. The results published herewith are immediate results only; later we expect to report the ultimate outcome of these cases.

CASES.

Case 1. Non-suppurative tuberculosis of the epididymis: Section of the cord en masse between the ligatures: Disappearance of tuberculous nodules: No consecutive atrophy. Retrogression of vesicular and prostatic lesions. Patient aged 20. Swelling of testicle without gonorrhoea in July, 1899, with partial resolution. Gonorrhoea contracted shortly afterward with exacerbation of orchitis. Consultation Oct. 16, slight hydrocele. Hard, sensitive nodules in both head and tail of epididymis. Vas deferens seemed healthy. The prostate was enlarged with a hard nodule in the right lobe. The left seminal vesicle was irregular in shape and nodular. The genito-urinary organs were otherwise normal. Examination of the chest revealed evidences of apical tuberculosis.

The operation was performed Oct. 18, under cocaine. The wound,

which was not drained, healed promptly, and without operative sequelae. Two weeks later the testicle and epididymis were notably diminished in size and were much softer. The nodules in the epididymis were still perceptible, but smaller, more supple and free from pain. Patient applied for and obtained his discharge. He was next seen March 30, 1900. The testicle on the operation-side appeared to be normal in every way and the vesicular and prostatic lesions had undergone retrogression. Crural adenitis was present, with tubercles on the opposite side.

Case 2. Suppurative tuberculosis of the left epididymis: Non-suppurative tuberculosis of the right epididymis: Total section of the cord and exposure of the lesions of the left side, followed by elimination: Total section of the right cord, followed by atrophy.

Patient aged 40. No history of gonorrhoea. The genital lesions of six months' duration. The right epididymis, nodular throughout; testicle apparently healthy; no hydrocele. On the left side the testicle is enlarged and hard but not irregular; the head of the epididymis apppears normal, but the tail is of the size of a small egg, the mass being tender, irregular in contour and adherent to the skin with presence of fistulous communication. The left vas deferens is irregular in outline. Both prostatic lobes and both seminal vesicles are tuberculous. Pulmonary lesions, not very far advanced. General condition good; no disturbance of urinary functions.

Operation Oct. 18, under general anaesthesia. On the right side, cutaneous inguino-scrotal incision, with ligature of the cord, followed by free incisions on the left side with laying bare of all tuberculous foci. Wound left open. Three days later hernia of the left testicle through the incisions in the epididymis. Profuse suppuration followed with gradual elimination of the testicle. The wound healed in about three weeks. Nothing remained in the scrotum, to the left, but a hard, insensitive nodule, the residue of the epididymis and testicle. On the right side the testicle was seen to have undergone notable atrophy. The prostatic and vesicular lesions had undergone no change. Patient discharged at his own request.

This case should have been treated, it appears, by orchidotomy and epididymotomy, with cauterization of the epididymal incisions, replacement of the organs in the scrotum and lateral drainage through the scrotal incision. Elimination of the testicle should not have occurred.

Case 3. Suppurative tuberculosis of the epididymis: Division of the cord en masse between two ligatures: Atrophy.

Patient aged 22 years, consultation Oct. 30, 1899. Gonorrhoea in preceding August, terminated in recovery during September. First noticed swelling of testicle on Oct. 28. History of pleurisy at the age of 18; had lost flesh thereafter.

Examination:—Right testicle slightly enlarged but not nodular. Epididymis exhibits nodules in both head and tail. Vas deferens permeated by small nodules. No abnormalities on left side. Prostate nodulated; right seminal vesicle enlarged, hard, uneven in contour and tender to pressure. No urinary disturbances. Lesions of pulmonary tuberculosis in the period of softening. Diagnosis of genital tuberculosis (despite the history of recent gonorrhoea).

Operation Nov. 4. Cord ligated en masse, under cocaine anaesthesia. Course of healing smooth. Upon his discharge Nov. 28, the testicle and epididymis formed a mass of considerable volume, but very soft and supple and free from sensitiveness. Condition of the prostate and seminal vesicle unchanged.

Case 4. Bilateral epididymal tuberculosis: Total division of the spermatic cord on both sides: Intense consecutive tumefaction. Sclerosis and late atrophy shown by autopsy, patient having succumbed to pulmonary tuberculosis.

Patient aged 31 years. First consultation Oct. 24, 1899. Had had syphilis and gonorrhoea in 1891 and hemoptysis in 1895 with subsequent repeated attacks of bronchitis. Fresh attack of gonorrhoea in 1898 followed by gleet. State of lungs became worse early in 1899. Tuberculous orchitis began in right side in July, on left side in August.

Examination:—Left testicle enlarged and of irregular outline, left epididymis very large, irregular and nodular. Abscess at tail of epididymis. Vas deferens appears healthy to touch. On the right side a cutaneous fistula which gives exit to caseous pus. Right epididymis irregular, nodular and the seat of an abscess. Vas deferens appears sound on palpation. Prostate enlarged, irregular, nodular; both vesicles enlarged and nodular.

Operation Nov. 1. Ligation of both cords. The abscess on the right side opened and curetted. Tamponnade with iodoform gauze.

On the second post-operative day the supervention of marked swelling led to the belief that a hematoma had formed. By Dec. 2, the testicles had diminished in size by one-half. The pulmonary lesions, however, were constantly proceeding from bad to worse, so that the patient died on Dec. 15.

Autopsy showed the testicles reduced in size by one-half. Tuberculosis of the tunica vaginalis. The microscope showed that the sem-

iniferous tubules were normal in number and size. There was no hypertrophy of the intertubular connective tissue. The epithelium of the seminiferous tubes was intact.

Case 5. Bilateral fistulous tuberculosis: Division of the right cord: Exposure of the tuberculous foci to the air: Orchidotomy and Epididymotomy without consecutive suture: Almost total elimination of right testicle. Ligature of the veins of the left cord according to Bier's method. Late amelioration.

The patient was first seen Oct. 10, 1899. The right testicle had been swollen for six months and the left testicle for one month. Both sides suppurated with formation of fistulae. Patient complained of fatigue, emaciation and night-sweats. Examination:—Ulcer on right side of scrotum opposite head of epididymis. Suppurative vaginalitis. Testicle enlarged but not nodular. Epididymis enlarged and nodular throughout. Vas deferens apparently normal. The left side of the scrotum normal, but traces of an old fistula existed. Testicle enlarged but not nodular; epididymis enlarged and nodular throughout. Vas deferens apparently normal. Prostate contained a nodule on the right side. Seminal vesicles normal.

Operation under general anaesthesia. On the right (fistulous) side, the epididymal foci were laid bare and curetted. The testicle was split. The organs were then replaced in the scrotum, and the wound tamponned with iodoform gauze, which served to keep the testicle from primary hernia. The entire cord was now ligated. On the left side ligature was applied only to the anterior and posterior veins of the cord; the sheath of the latter had been dissociated and was not included in the ligature.

The results of the intervention were as follows:—On the right side the testicle, which had not been sutured, was unable to keep its place within the scrotum, and was eliminated little by little, along with the epididymal foci. Eventually nothing remained but a fibrous nodule which gave to the patient the illusion of a testicle. On the left side, the ligation of the veins led ultimately to a diminution in volume of the epididymis and testicle. The prostatic lesions were not modified in any way.

When seen again three or four months later, a varicocele was found to be present on the right side, while to the left the fistula was closed. The epididymis and testicle were resistant and sensitive to a slight degree. The prostatic lesions had undergone some retrogression,

and the general condition was good. To sum up, ligature of the veins gave a good, albeit a late result.

Orchidotomy ought always to be followed by suture, because a tamponnade is insufficient to retain the testicle within the scrotum. Our aim was to allow the lesions to be exposed to the air indefinitely, but the patient was very intractable.

Case 6. Non-suppurative bacillosis of the epididymis: Resection of the cord: Incision and cauterization of the tuberculous foci and return of the organs within the scrotum: Cure through atrophy.

Patient aged 21; consultation Dec. 5. Gonorrhoea one year before with rapid recovery. One month before consultation the left testicle became swollen and painful, without apparent cause.

Examination:—The entire epididymis is much swollen, chiefly the tail. No signs of softening. No hydrocele. Inguinal hernia of the same side. Vas deferens enlarged and indurated as high as the inguinal canal. The right testicle and appendages are healthy. The prostate is enlarged, but not nodular. Seminal vesicles unchanged. No urinary disturbances. General condition poor, patient emaciated, coughs; rough breathing over both apices.

Operation Dec. 8. Mass ligature of the cord at the point of exit from the abdomen, or even higher. Anterior wall of inguinal canal incised to perform the radical operation for inguinal hernia. Resection of the wall of the canal and of the cord between two ligatures, and application of the thermocautery to the stumps. Enucleation of the testicle with its tunica vaginalis. Incisions 3 c. m. deep into the tuberculous epididymal foci, for the purpose of exposing the latter to the air, the incisions being treated with the thermocautery. The testicle and appendages were replaced within the scrotum. Complete cutaneous suture without drainage.

The wound appeared to be healing by first intention, but supppuration unfortunately set in on the tenth day, and persisted for a fortnight. The tuberculous mass diminished in size little by little and on Feb. 10, was of the size of a large nut. The size of the prostate underwent no change, while the seminal vesicles appeared to increase in volume. The general state of the patient was good at his discharge.

Case 7. Fistulous tuberculosis: Total resection of the cord: Curettage: Atrophy with fistula remaining patent for a long period.

Patient aged 24 years. First consultation Dec 10. No history of gonorrhoea. The left epididymis had begun to swell two years before. Abscess formed and discharged for a year.

Examination:—Postero-inferior scrotal fistula discharging pus

which contained caseous debris. The entire tail of the epididymis involved. Vas deferens slightly increased in size. Considerable hydrocele. The right testicle is healthy. The prostate contains multiple nodules, while the seminal vesicles are still normal. No urinary disturbances. General condition good, no pulmonary troubles. The patient requested conservative treatment.

Case 8. Fistulous, genital tuberculosis, right-side: Total division of the cord: Testicle and epididymis reduced in size to the volume of a nut: Non-fistulous, genital tuberculosis, left-side: Total section and cauterization: Atrophy with persistence of fistula.

Patient aged 22. Consultation Nov. 14. History of tuberculous cervical adenitis, suppurative in childhood. For past 4 years epididymal tuberculosis, suppurative, of right side. Fistula still persists. For the past six months tuberculous nodules in left epididymis. Intermittent discharge from the urethra, which contains no gonococci.

Examination:— Right side—hard nodule in the epididymis; testicle and vas deferens apparently healthy. Scrotal fistula. Left side —the tail of the epididymis forms a large, hard mass, irregular, insensitive, with adherence of the integument. No hydrocele. Vas deferens normal. Prostate voluminous, irregular in shape, nodular. Left vesicle not recognizable to the touch. Right vesicle irregular, nodulated. No urinary troubles. General condition good. Lungs apparently sound.

Operation Nov. 16, under general anaesthesia. The right cord ligated and divided *en masse*. Lesions in epididymis laid open and exposed to the air. Cauterization and curettage of the tuberculous focus. Same operation practiced on the left side, where an epididymal abscess was present. On both sides the ligature was made after first dissociating the cord from its sheath, in order to avoid ligation of certain vessels necessary for the success of the testicular graft.

Suppuration was very abundant on the left side after the operation. After Dec. 15, the tuberculous masses began to diminish in size, from a third to a half on the left side, but with persistence of fistula. The tendency of the latter is towards closure. On the right side the genital mass is normal. On March 9, a small fistula is present on the left side. The testicle and epididymis form a soft mass the size of a nut. To the right the testicle and epididymis form a hard mass the size of a nut, ascending to the inguinal orifice. The prostate is reduced in size; the right vesicle is still palpable. Aside from the persistence of the fistula the result may be called extremely good.

Case 9. Suppurating epididymis: Ligation en masse of the

cords with the exception of the posterior group of veins: Consecutive atrophy.

Patient aged 20. First consultation Jan. 15, 1900. Had suppurative right orchitis, Oct., 1898, with rapid production of fistula. After closing it reöpened in Sept., 1899, after the patient had contracted a gonorrhoea; while at the same time the epidiymis of the left side suppurated.

Examination:—On the right side, a large abscess of the epididymis, with suppurative adenitis. On the left side the epididymis is enlarged and tender to pressure. The prostate is but little enlarged and insensitive. The left seminal vesicle is normal in contour but tender to the touch. The right vesicle is enlarged and tender; pressure applied to it causes pus to exude from the urinary meatus. Considerable fever is present (39° C).

Operation Jan. 24. General anaesthesia. Dissociation of the sheaths of the cord. After application of the ligatures, the epididymal nodules were cauterized with the Paquelin.

Three weeks later, (Feb. 15), the genital mass on the right side is smaller; a fistula persists, and the testicle is still tender to touch. To the left there is slight suppuration and the testicle is not tender to pressure. The prostate is large.

One month later, (Mar. 15) the right testicle is soft, smooth and of the size of an egg. The epididymis is much reduced in size, hard, nodular and painful, with the presence of a scrotal fistula. The left testicle is of the size of a small nut, firm, smooth and quite insensitive. A scrotal fistula is present, the discharge being much more abundant than on the other side. The prostate is enlarged; the urethral discharge proceeds from the prostate. Fever is gone, and the general state is improved.

Case 10. Tuberculous epididymitis of the hypertrophic type: Ligature of the cord with the exception of the posterior fasciculus of veins: Cauterization of a cold abscess: Consecutive atrophy with temporary secondary fistula.

Patient aged 15. Consultation Jan. 22, 1900. Emaciation for some time past, and enlargement of right testicle for two months preceding.

Examination:—Right epididymis much hypertrophied, hard and nodular. The vas deferens indurated. No urethral discharge, no urinary disturbances. Prostate and vesicles normal. Roughened breathing at apices. General condition good.

Operation Jan. 24. Sheath of the cord isolated. Ligature of the

entire cord excepting the posterior fasciculus of veins, and division between two ligatures. The nodules in the tail of the epididymis were cauterized with the Paquelin; and a small, latent cold abscess was opened. The mass so treated was returned into the scrotum and the skin sutured. No febrile reaction followed.

About three weeks later the genital mass was much smaller. The wound had healed by first intention save at one point, which remained tender and gave vent to a discharge. A small abscess formed later and was opened above and below and drained.

After another month the affected testicle felt smooth and was not painful. The epididymis was much smaller, and uniform in contour. The vas deferens was clearly increased in size. Two weeks later the wound closed, the testicle then exhibiting normal characters.

Case 11. Fistulous, tuberculous epididymitis: Ligature of the entire cord and cauterization of the foci of the disease: Consecutive atrophy.

Patient aged 32 years. First consultation Jan. 15, 1900. Father died of pulmonary tuberculosis. The patient has had bronchitis for the past seven years. Orchitis began eighteen months ago, and led to abscess and fistula.

Examination:—The tail of the right epididymis contains multiple nodules, suppurating, fistulous and adherent to the skin. No hydrocele. The tail of the left epididymis is also nodular and adherent to the skin and shows the recent cicatrix of a fistulous tract. The prostate is enlarged and nodular but the seminal vesicles are normal. The patient has pulmonary tuberculosis.

Operation Jan. 17, under general anaesthesia. The sheath of the left cord was isolated, and the vessels, nerves and vas deferens ligated *en masse*, between two ligatures. The citratix in the tail of the epididymis was cauterized with the Paquelin. The right cord was tied *en masse*, with the exception of the posterior veins, between two ligatures, the fistula was incised, curetted and cauterized with the Paquelin.

After the operation there was some fever, with profuse suppuration of the fistula. In four weeks' time the genital structures had undergone a very notable diminution in size on both sides. The left testicle was insensitive, while the right was still tender to pressure.

Two months after intervention, the left testicle and epididymis were very small, hard and insensitive; while on the right side the corresponding structure had undergone further diminution in size. They were still tender and a few nodules were still present in the epididymis.

There was a tuberculous formation in the scrotal integument which required excision.

Case 12. Tuberculous epididymitis of the left side etc. (This case has already been described in a preceding section.)

In conclusion we cannot sufficiently express our obligations to Drs. Humbert and Picqué for their courtesy in permitting us to operate on the foregoing cases from their services in the Hopital Ricord and Hopital Bichat.

CASES OF LIGATION OF THE CORD FOR TUBERCULOUS EPIDIDYMITIS RECORDED BEFORE OUR RESEARCHES WERE UNDERTAKEN.

I. Harvey (cited by Broca in his *Traitè des tumeurs)* is said to have caused the disappearance of testicular tumors by ligating the arteries in the cord. II, III, IV, Maunoir reported three cases, (the first two cases recorded in his *Memoir sur le traitement du sarcocele par la ligature arterielle,* and the others in the *Melanges de chirurgie etrangère,* tome II). The first patient was a military man aged 30 who had sustained a trauma of the testicle which led to the formation of multiple abscesses of the scrotum. Maunoir tied the spermatic artery and nerves. The operation was followed by prolonged suppuration which finally ended in resolution. The testicles underwent atrophy.

The second patient was 35 years old and had had orchitis for a year with an extensive hydrocele which had been punctured repeatedly. Ligation of the spermatic artery was followed by a return of the testicle to its normal volume..

Maunoir's third patient had had multilple tumefactions of the testicles for several years. The spermatic artery was tied without any effect upon the testicle. The patient, who refused to submit to ligation of the cord *en masse* was subsequently castrated.

V. Lannelongue (Tumeur du testicle traité et guerie par la ligature de l'artere spermatique) *Gaz. des hopitaux,* Jan. 12, 1875.

The patient, who was aged 49, was an ataxic; the tumor, which was on the left side, had been present for about a year, and was now of the size of the fist and sensitive. The patient had had syphilis, but specific remedies had no effect upon the size of the tumor. The spermatic artery was then ligated and the volume of the testicle reduced to that of a nut, the sensitiveness disappearing at the same time. The author believes the case to have been one of syphilitic testicle.

VI. Skey (Suppurative tuberculosis of the testicle: Ligature of the spermatic cord followed by gangrene and elimination of the testicle through the ulceration in the scrotum.) *London Lancet*—1862, p. 647.

On account of the patient's weakness Skey regarded castration as out of the question. In practicing ligation of the cord, he hoped to cause either atrophy, or elimination of the affected organ. After profuse and protracted suppuration with gradual and complete elimination of the testicle, the wound healed, with the cure of the local lesion.

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REVIEW OF CURRENT LITERATURE.

THE PREVENTION AND CURE OF PHTHISIS.

Hambleton (*The Lancet*, Dec. 28, 1901) refers to his "experiments and observations in phthisis" which go back to 1873, comparing them with the views of to-day, which of course are based on bacteriology. He has always taught that the phenomena of the disease are of toxic origin, but is inclined to regard this element as a retained excretion product, the retention being due to a defective aeration-surface in the lungs.

While this theory may not be in harmony with the teachings of to-day, it leads at least to practical results; since the indication in treating the disease is to multiply the breathing-area, by increasing the thoracic capacity up to certain standards of measurements and spirometry.

The open-air treatment directly favors the interchange of gases and elimination of the retained toxic substances. The scrupulous care of the skin which is practiced at the present day is also in the line of vicarious elimination. The early stages of the treatment comprise out door life, care of the skin, etc., while the respiratory gymnastics come into play after the arrest of the disease. The author cites numerous cases of recovery, due to carrying out his hypothesis, including his own personal one, he himself having recovered from the disease in 1876.

[Dr. Hambleton appears to be a good example of a type of scientist which is rapidly becoming extinct. It does not appear that he has ever made the slightest attempt to isolate, imitate or predicate the characters of this unknown toxic retention-product. It is much easier to theorize than to do hard laboratory work. Fifty or seventy-five years ago, medical literature abounded in efforts of this sort. The men who write thus are not visionaries, but in many cases highly competent to express opinions upon almost any subject. They simply do not learn that science is a matter of experiment, not of speculation.—Ed.]

COUGH AND EXPECTORATION.

These subjects are considered exhaustively by Strübing in the *Deutsche Klinik*, 1901, No. 6.

Cough comes either from direct or reflex excitation of the cough-centre in the medulla, and in the vast majority of cases is due to reflex

excitation from the respiratory apparatus (normal reflex). When cough exists without any evidence of central or peripheral irritation it is styled *nervous*. Since coughing is a conservative phenomenon, which has the effect of keeping the air passages clear of obstruction, a *nervous* cough is a superfluous act.

In some diseases cough is invariably present, while in others it may or may not occur. Experiments on animals show that the localities which provoke cough when irritated are the mucous membrane of the larynx, especially of the interarytenoid area; of the trachea, especially its posterior wall, and finally of the bronchi. On the contrary, irritation of the lung parenchyma—the air-cells—does not provoke cough. It is not necessary that it should, for the irritation of the terminal bronchi answers the purpose of clearing the lung-tissue proper. Irritation of the pleura does not necessarily produce cough, and when the latter accompanies pleurisy the reflex should proceed from a coincident laryngitis or bronchitis. It must be confessed, however, that after the development of traumatic pleurisy, attempts at deep inspiration sometimes cause cough-movements. After the subsidence of the pleurisy cough can no longer be induced in this manner. Irritation of the pleura may therefore provoke cough under certain conditions. The part played by the larynx in the genesis of cough is similar in character to the preceding. We seldom see this symptom produced by acute pharyngitis. On the contrary, it is by no means unusual to see cough accompany chronic pharyngitis.

In some instances cough has a mixed origin, as when secretion from above drains into and thereby irritates the larynx; or when nasal stenosis leads indirectly to the same result through alteration in the quality of the inspired air. *Ear-cough* is to be regarded as a physiological reflex due to irritation of the auricular branch of the vagus (as by foreign bodies).

Cough of central origin may be due to irritation of the cortex cerebri or of the medulla itself. So called habit-cough is probably of cortical origin, while direct irritation of the cough-centre occurs in inflammation or injury of the bulb. The inhibitory power which the patient possesses over his cough is of course derived from the cortex, and in this Niemeyer is quoted with apparent approval as to his belief that mothers should always exhort their children unceasingly to stop coughing during the course of pertussis, and should even threaten them with punishment.

What has been said of cough thus far has been confirmed by ani-

mal experiment. But there are other clinical varieties which cannot be thus reproduced artificially, and in which the irritable zone may be in the mammae, skin, ovaries, testicles, prepuce, etc., in which localities friction or pressure may be sufficient to arouse paroxysms of cough. The latter may be associated with sounding the uterus, compressing an enlarged liver or spleen, the passage of gall-stones or renal calculi, etc. It may vary in consonance with disease of the stomach (so-called stomach-cough). There is also the so-called trigeminus-cough in which the afferent impulse comes from some locality supplied by the fifth nerve, especially the nasal mucosa.

In all these forms of reflex cough the supposition of a neuropathic substratum appears justified by clinical facts, the subjects often exhibiting the phenomena of neurasthenia or hysteria. In cough with the ordinary bronchial reflex, which of course occurs without predisposition, a hysterical patient will exhibit paroxysms out of all proportion to the degree of local mischief, and in these individuals the cough persists oftentimes after complete recovery from the bronchitis. This is doubtless the rationale of some cases of so-called nervous cough. Under these circumstances a sort of generalization of the pathological reflex may occur so that other areas become irritable. It is perhaps in patients thus affected that we should expect to see a *uterine cough* supervene in connection with coitus or tamponing the cervix; or a pharyngeal cough develop in connection with lateral pharyngitis, hypertrophy of the tonsillar ring, etc. We are therefore obliged in a given case of cough to determine as far as possible how much of it is due to this element.

The subject of reflex-cough is still unexhausted, but it is perhaps sufficient in this connection to state that there is hardly any limit to its possibilities if we consider all the elements of the source of irritation, irritable area, etc.

The physiology of the act of coughing is sufficiently familiar, but recently the claim has been made that the larynx is not forced open by the air-pressure, and that the abductors of the cords contract actively, the column of air then escaping with the loosened secretions. Doubtless cough is effected by the joint action of air-pressure and active opening of the glottis.

There are three degrees of coughing:—1. The act of clearing the throat; 2, ordinary cough; and 3, paroxysmal congh. These degrees result from the varying part played in a given case by the amount of local irritation and the irritability of the nervous system.

With time a certain amount of tolerance develops in chronic cases; thus many phthisical subjects have surprisingly little cough, although a large portion of the bronchial mucosa may be in a state of irritation.

While the cough which accompanies disease of the larynx, trachea and bronchi is associated with a pathological state the reflex is a natural one, which should be produced at will in the healthy subject by irritation of those areas. But when the cough proceeds from the nose, pharynx, liver, uterus, etc., the reflex itself is pathological, and people who develop these types of cough undoubtedly possess a substratum of neuropathy. In none of these types should we expect to see tolerance develop.

While pertussis is the type of paroxysmal cough, it is closely imitated in acute laryngitis, in the laryngeal crises of locomotor ataxia, etc.

The general consequence of cough is to increase the intra-thoracic and intra-abdominal pressure, with tendency towards emphysema, hernia, displacement of the uterus, abortion, vomiting, involuntary evacuations, etc. Further the disturbance in the circulation of the superior vena cava tends to produce cerebral congestion and haemorrhage, and in association with the suspension of inspiration, to cause cyanosis.

Numerous phenomena of cough are of especial interest to the laryngologist, who, alone is able to study them.

Expectoration:—The sputum of a patient should be received into a glass containing a stratum of water for the purpose of preventing desiccation. Its consistency, amount of contained air, color, transparency, stratification and odor should be noted.

The old division of sputum into mucous, muco-purulent and serous is based upon the varying proportions of mucous, cells and water present. Mucous expectoration is the expression of the activity of the mucous glands, and accompanies every mucous catarrh as long as the glands remain intact. If there is much serous transudation the mucous is liquefied to a greater or less extent, and in extreme cases can be recognized by chemical means alone. A relative excess of mucous gives the sputum a tenacious and adhesive quality.

Pneumonic expectoration does not owe these qualities to mucin, but to nuclein which is formed from the cells by the pathological process. As the rusty color of this sputum may fail, the presence of tough, adhesive expectoration may or may not indicate pneumonia in doubtful cases. Under these circumstances the macroscopic stain of A. Schmidt

will decide the diagnosis. The reagent consists of 1 part Biondi's powder to 30 parts distilled water (this test is described in detail in *Volkmann's Samml. Klin. Vorträge*, N. F. 1898, No. 202).

To the ordinary tenacious, vitreous, colorless and transparent sputum of beginning acute catarrh, pus-corpuscles are gradually added until a yellowish or grayish yellow hue is produced, while the original transparency is replaced by cloudiness. The serous transudation which accompanies the pus-corpuscles renders expectoration more free.

Muco-purulent secretion accompanies chronic catarrh as long as the mucous glands are intact. The components may be intimately mixed or may form different strata on standing (translucent mucous, opaque pus). The greenish tinge which is present at times is due to an alteration of the coloring-matter of the blood, due to the intensity of the inflammatory process.

Sputum which consists of pure pus could occur only in the case of rupture of a pulmonary abscess or empyema into the bronchi.

A purely serous expectoration is seen only with oedema of the lungs. It usually possesses a slight red tinge and is foamy. Thin sputum mixes much more readily with the air, and the amount of the latter varies with the consistency of the sputum as well as with the character of the cough itself, violent paroxysmal efforts naturally producing a higher degree of admixture.

Sputum which sinks in water is not characteristic of cavernous affections of the lungs, although a nummular shape—which indicates a small admixture of mucous—gives a presumption of such origin. The contents of a cavity, when forced through a small opening are identified at times through the threadlike form acquired in this manner.

The stratification of muco-purulent sputum is as follows: The three layers produced by allowing the expectoration to stand in water are from above downward the *foam-stratum*, which consists of air bubbles originally derived from both the mucous and the serum of the pus; the *middle layer* which, however, is well marked only when there is an abundance of pus-serum, since it consists entirely of the latter, and finally the *lower stratum* which adheres to the bottom of the glass and comprises all the formed or solid elements.

The color of sputum is modified chiefly by the amount of blood-coloring matter which is furnished by such red corpuscles as enter by diapedesis or by haemorrhage. Diapedesis occurs in connection with intense inflammation, stasis, infarction and haemophilia. Haemor-

rhage accompanies ulceration, traumatism, rupture of aneurisms and varicose venules; in connection with tumors and parasites, etc.

Aside from blood-coloring matter in the natural state, certain derivatives of the latter play a prominent rôle in tingeing the sputum. We see this exemplified in the rusty pneumonic expectoration and also in the green tinge in the same disease from delayed lysis, and in florid phthisis (especially the type which develops upon a pneumonic foundation).

Pneumonic expectoration may also be tinged green if icterus coëxists.

When sputum develops unusual hues upon standing, such as bright yellow, bluish, etc., the tinctorial influence of bacteria is in evidence (b. pyocyaneus, b. virescens, etc).

When such coloration is associated with malignant disease the source of the coloring principle is obscure. In considering the question of the hue of expectorated matter we must always bear in mind the possibility of the inhalation of coloring matters in connection with the arts (English red, ultramarine, etc.). Other rare peculiarities in coloration are seen in chylous sputum, in oesophago-tracheal fistula (from the food or drink), from the multiplication of fungi, etc.

The amount of sputum varies with the extent and intensity of the pathological process. In the height of a catarrh it is greatly increased in comparison with the beginning. If the lymphatic circulation is impeded the amount of sputum in twenty-four hours may exceed 2 litres.

The macroscopic study of the sputum is best carried out as follows: It should be spread out upon a saucer, and in this manner bits of necrotic tissue, cartilaginous or alveolar, etc., may come to light, indicating ulceration or gangrene; or lime-concretions from calcified tuberculous foci; or grayish greenish cheesy fragments in caseous tuberculosis. In the latter products especially, do we search for tubercle-bacilli and elastic fibres. Other formations, which strongly resemble the products of tonsillar crypts, are the so-called Dittrich's plugs, which are found especially in putrid bronchitis and consist principally of bacilli in bulk with crystalized fatty acids. Other objects, occasionally encountered are fibrin-coagula, casts of the finer bronchioles, false membrane (in bronchitis crouposa) Curschmann spirals, parasites, foreign bodies, etc.

The microscopical examination not only follows up the study of the objects revealed by the naked eye, but is also able to make the diagnosis independently. At first a smear is made of the fresh sputum

and the latter is thus studied microscopically as a whole. If solid particles are present on the cover-glass, they are crushed.

If the sputum is mixed with saline solution and allowed to deposit, the mucous sediment will be found to contain leucocytes or pus-corpuscles in varying number with the gross amount of pus. These elements are mostly polynuclear, as shown by the addition of 1 per cent. acetic acid. Eosinophile cells are present in various catarrhal affections but are far more abundant in asthma where they form 60 per cent. of the leucocytes. The proportion of eosinophiles is said to increase greatly in tuberculosis when that affection begins to improve.

Alveolar epithelia occur in the sputum under various circumstances. When there is a prolonged and abundant presence of cells containing lung-pigment tuberculosis should be suspected. These cells exhibit a yellowish-brown, granular pigment in brown induration and have therefore been termed "heart-disease cells," but occur also in pneumonic processes, infarctions and as a sequence of hemoptysis. The substance which colors these cells is known as hemosiderin, which unlike hematoidin contains iron. The alveolar epithelia also contain myelin granules, which may find their way into the sputum. They occur most commonly in catarrhal pneumonia.

Elastic fibres occur in connection with abscess and gangrene of the lung and tuberculosis. The fragments of tissue which may contain them represent portions of the frame-work of the lung parenchyma. Their occasional absence in gangrene of the lung has been accounted for by the solvent action exerted upon them by a trypsin-like ferment which is formed in that disease. Isolated elastic fibres still have a diagnostic value in tuberculosis when bacilli cannot be found (provided of course that abscess and gangrene can be excluded).

If there is evidence of tuberculosis without the ability to find elastic fibres a special search should be instituted by collecting a large amount of sputum, and treating it with weak soda-lye; after which the fluid is centrifugated. The process may be repeated with the sediment. When the secretion of the lungs stagnates and is decomposed, large amounts of needles of margaric acid are formed. More rarely cholesterin crystals are found under these circumstances. Coffin-lid crystals of triple phosphates may accompany the preceding forms.

The Charcot-Leyden crystal is seen especially in asthma, along with Curschmann's spirals. It is possible that these formations are derived from the eosinophile cells which also accompany the same affection.

The bacteriology of the sputum has been so thoroughly discussed in medical literature that it will suffice to call attention to a few important points. Thus the Fraenkel and Friedlander pneumococci, the strepto- and staphylococci inhabit the nose, mouth and throat of healthy individuals; so that the sputum after its passage through the two latter structures should be washed repeatedly to free it from saliva, etc.

The microörganisms just named may be regarded as the causes of ordinary bronchitis, while influenza has a specific bacillus. In putrid bronchitis the ordinary exciters of putrefaction are likewise present.

In enumerating some of the numerous tests for the tubercle bacillus emphasis is laid upon the Spengler method according to which the sputum is first digested with pancreatin. After digestion is under way a small quantity of carbolic acid is added to prevent decomposition. A sediment is present after digestion and should be investigated for the bacillus.

The bacillus of pulmonary gangrene resembles greatly the bacillus tuberculosis, taking the same stain. It is, however, decolorized by absolute alcohol.

Pneumonia of the acute croupous type may be caused apparently by a large number of germs, new ones being added to the list from time to time. The same may be said of broncho-pneumonia, no less than 7 pathogenic bacteria having been identified with this affection. Naturally, with such possibilities mixture of infection is sufficiently common.

In croupous pneumonia from the pneumococcus, we may look forward to a crisis with favorable termination, save in cases of special virulence as seen in old or alcoholic subjects. If streptococci are associated with pneumococci, the crisis will probably fail to develop and as a result the patient dies or recovers very slowly.

In plague-pneumonia the bacillus pestis may be found alone or associated with strepto- and diplococci.

Pathogenic bacteria which occasionally appear in the lungs are those which cause anthrax, glanders and lepra.

Actinomycosis, aspergillosis and other diseases due to fungi may affect the lungs and appear in the sputum.

ON THE RECIPROCAL RELATIONS OF SANITARIUM AND TUBERCULIN TREATMENT.

Weicker (*Berl. Klin. Wochenschr.*, 1902, No. 4) speaks of the credit awarded to Germany at the late British Congress of Tuberculosis for its initiative in compelling workingmen to insure themselves as a step in the warfare against tuberculosis, and cites numerous statis-

tics calculated to show the good work which is being accomplished in placing incipient consumptives in a condition to resume their means of livelihood.

At the present time, there are 59 people's sanatoria in operation in Germany and this number will shortly be increased by 35 others.

There are also 16 private institutions which receive the same class of patients. It is now even implied familiarly that this is the only method by which the disease can be effectually treated (Koch appears to have expressed this view at the London Congress).

This opinion appears to be based upon the claim that 20 per cent. of patients lose their "bacilli-expectorating capacity" after sojourning in sanatoria. This, according to Koch, is the only actual evidence of recovery, or at least in respect to prophylaxis to others. This can hardly be evidence that the disappearance of the bacilli is tantamount to recovery, for many of these patients live after the discharge in accord with the principles of hygiene in vogue at the sanatorium, that is they continue to disinfect their sputum, and take other measures to protect those around them.

The original idea of Brehmer was to detain patients in sanatoria until they were completely cured. To-day we agree with Brehmer in placing these patients in sanatoria, but differ with him in discharging them after 13 weeks' treatment, a period certainly too short for recovery. Dettweiler has said that two things are requisite for sanatorium-cure—money and character; and the lack of means would of course bar out the working man as far as private treatment is concerned, and only the aid of the State makes it possible to place the man of no means in a position to receive the benefit of sanatorium-treatment.

While the wealthy are chiefly anxious to preserve their lives, the laborer wishes above all things to save his ability to work. It stands to reason that only a healthy individual is able to toil; so that it is a practical criterion of recovery. In other words the people's sanatorium must do a stipulated amount of work within a definite time. The *average* duration of treatment is 13 weeks; which means that within that period the institution undertakes to enable an incipient consumptive to earn his bread for an indefinite length of time.

The test of admission to treatment is not the technical period at which the disease is incipient, but the ability of the case to respond to treatment. The examining physician should be expected to determine the eligibility of a patient along these lines.

When these individuals are discharged, the responsibility of the sanatorium does not end, for a not inconsiderable proportion of those

who have been discharged will certainly become worse, even in spite of all care. This class also becomes dangerous to its environment. Every means has been put in operation to enable these patients to retain their health:—convalescent-hygiene, proper sanitation of dwelling-houses, change in the kind of labor, etc. Every informed person understands the gigantic size of this problem. Weicker confesses that his percentage of "discharged, able to work," cases which he did not feel certain of as to recovery, and would not pronounce cured, is very large. There is, however, no known test of cure which can be applied to suspicious cases, unless tuberculin is such, a point which is still in dispute.

Weicker, himself, is convinced that the time will come when the custom of trial injection of tuberculin will come into general use; like vaccination, however, it is bound to have opponents.

If this custom should become general, it would be possible to determine readily whether a patient was suitable for discharge. If the injection were followed by a negative result, he could depart, otherwise the ability to work would not obtain his release.

The expression "able to work," does not imply that a patient is restored to his full capacity and able to earn his regular wage. These patients are simply supposed to be able to earn at least 33 per cent. of the regular amount paid for their work in the districts in which they reside. Many are unable to earn over 40 per cent. We should have a higher aim than to expect convalescents to work; our ambition should be to turn out individuals able to be classed as "100 per cent. capable."

The sanatorium-movement appears to have reduced the mortality of consumption but there may be errors at work here—cases may simply have lingered on without a fatal termination. Such an error would be exposed in time unless the increasing number of sanatoria should constantly exert a contrary influence.

The isolation of incurable, indigent, bedridden consumptives in special sanatoria is thought to have aided in lowering the mortality in England.

But tuberculin, already alluded to as a diagnostic resource, has, in the opinion of Weicker, still another future. He believes, in fact, that it is curative in selected cases, and that it will add to the efficiency of the usual sanatorium-treatment. The remedy should be given in the usual manner of increasing doses with intermissions. The idea of the combined method does not mean that the two resources are to be used side by side. The purely hygienic treatment first comes into play to increase the natural vigor of body and mind; and when the desired

results have been obtained the patient should receive a thorough inoculation with the tuberculin to destroy the foci of disease which may still persist. A person thus treated ought to be so fortified as to be termed actually cured.

THE SANATORIUM TREATMENT OF CONSUMPTION.

Drs. Dyce Duckworth and E. D. Marriott, having recently attacked this method of the management of consumption, replies by Drs. Latham and Jackson respectively, may be found in the *London Lancet*, Jan. 11, 1902.

Dr. Marriott, having implied that several years appear to be necessary for a sanatorium-cure, Dr. Latham replies that such a prolonged sojourn may be advisable to secure permanent recovery, but adds that men like Brehmer and Walther regard 4 to 6 months as the average sojourn required for cure, as judged by records which extend back for many years. The claim of Marriott that the expenses necessitated by two or three years of sanatorium-life are prohibitive could not hold if compulsory insurance were in force as in Germany.

In answer to Marriott's claim that a sanatorium for consumptives means a concentration of infectious germs, Latham states that the precautions in vogue to destroy the germs and arrest their spread render a sanatorium more free from bacilli than the average English dwelling.

Marriott appears to think that the best prophylaxis of phthisis is found in increased per capita breathing space and better drainage. This, Latham thinks, is one of the very best arguments for sanatoria for the poor, who suffer from precisely those unhygienic conditions.

Marriott's plea that the consumptive requires individual attention and not the wholesale methods supposed to obtain in sanatoria, is answered by Latham with citations from sanatorium-physicians who reckon among their privileges the opportunty of giving each inmate much more personal consideration than he could possibly obtain under any other system.

Dr. Jackson, himself a sanatorium-practitioner, also answers Marriott's arguments in detail. He objects to the idea that sanatorium-patients are necessarily crowded together, because they are inmates of the same institution. The flocking of patients is in fact discouraged. He knows of no evidences of reinfection or other alleged ill possibilities in the history of sanatoria. Ventilation is carried out to an extent impracticable if not impossible in home-life; so that sanatorium patients lead a life almost tantamount to one in the open air. The

gain in knowledge alone which accrues to patients as to the necessity and benefits of fresh air is of immense value to the community. Nothing could be more unfortunate than Marriott's comparison between sanatoria and prisons.

Finally sanatoria do not have a monopoly of fresh air. It is possible to observe the same routine at home, especially after experience in sanatorium-life.

Incidentally Jackson speaks of the poor teeth possessed by most consumptives and need of fillings, etc., before treatment.

BOOK REVIEWS.

A Text-Book of Physiological Chemistry. By Charles E. Simon, M. D., of Baltimore. 453 Pages; cloth. Lea Brothers and Co., Philadelphia and New York, 1901.

This book, following the author's excellent work entitled, "Clinical Diagnosis," covers a field which is deserving of much more attention than is generally devoted to it. It seems to be accurate, concise, and at the same time clear and comprehensive.

All of the known facts have been pointed out and the theories deduced to explain complex problems of metabolism will appeal to the reader as being the most probable when reasoning from the analogy of the known.

The plan of leading up from the probable simple origin of substances which constitute the complex tissues of plants to the subsequent building up processes in the formation of the still more complex substances of the animal body, affords a clear and logical explanation of the probable syntheses of the latter. One thing, however, which seems to the writer to have been given too little attention is the discussion of the so-called organized ferments. The author says, "While some of the ptomains are apparently harmless, others are exceedingly poisonous, and these last are accordingly spoken of as toxins." That some ptomains are poisonous is well known but to class these as toxins is not in accordance with the more advanced classification. A ptomain is a basic substance. It unites with acids to form salts. Its chemical structure is comparatively simple, and it is formed from the breaking down of complex albuminous bodies. It is then an analytical product. The most poisonous substances produced by *organized ferments* are not basic and do not unite with acids to form salts. They are not simple compounds, many of them being exceedingly complex, and, owing to this latter fact together with the exceedingly small amount which can be isolated, their chemical formulae have never been ascertained. That they are synthetic products has also been proven from the fact that when the organisms which produce them are grown on relatively simple organic substances, the highly complex toxic product is formed. Moreover they are not proteins. To these substances the term *toxin* should be limited and should not include ptomains, some of which at least are formed by other agencies and are not a specific product of the action of so-called organized ferments. The toxalbumins which are simply mentioned, and which might also have included the toxalbumoses and toxo-peptones do not, in all probability, owe their poisonous properties to their protein constituents, but simply carry down mechanically the toxin when they are precipitated.

That this is probable is shown from the fact that when they are freed from protein until they do not respond to the protein tests, they are vastly more poisonous than before such a separation has taken place.

A short abstract of Buchner's work on complete fermentation in the absence of the living cell, although not accepted by all, would have been an addition of worth to the reader.

As a whole the book offers little for criticism. It is not a mere compilation of the work of others, but, on the contrary, embodies in it much that is original. An excellent feature which it possesses and one which should especially commend it to all those interested in this important subject, is that false theories have been generally corrected while attention has been directed to many things which have been recorded as facts in works of similar nature and which have in numerous instances long since been disproved.

System of Physiologic Therapeutics. Vol. III 336 pages, and IV 420 pages, on Climatology, Health Resorts, Mineral Springs. By F. Parkes Weber, M. A., M. D., F. R. C. P., (Lond.), Physician to the German Hospital, Dalston, etc., with the collaboration for America of Guy Hinsdale, A. M., M. D., Secty. American Climatological Association, Pres. Pennsylvania Society for Prevention of Tuberculosis, etc. Edited by Solomon Solis Cohen, A. M., M. D., Professor of Medicine and Therapeutics, Philadelphia Polyclinic, Lecturer, Clinical Med., Jefferson Medical College, etc. Illustrated with maps. Philadelphia: P. Blakiston's Son & Co., 1901.

When completed this work will comprise eleven volumes of which the first and second deal with electrotherapy exclusively. Volume III is concerned with an account of the climate and health resorts of Europe, preceded by a short introduction upon the subject of climatology in general. In Vol. IV we find a corresponding account of the climate and health resorts of America, Asia, Africa and Australasia, together with a section upon climato-therapy.

The introductory section upon climatology may be characterized as a study of what is commonly known as physical geography, including its phyisological action upon the human organism; this is the sort of book to inform us as to the effect upon mankind of sunshine, altitude, humidity, extremes of temperature, etc. The subject, however, is clearly in its infancy; and the statistical method must be employed extensively before we can obtain the data necessary for the creation of a science of climato-physiology and climato-pathology. Interesting studies of the effects of the weather upon the commission of crime, of suicide, drunkenness, hospital attendance and the like have been published within recent years, but we see no reference to this sort of investigation in the present work.

Those sections of the two volumes which refer to individual health-resorts, need only an alphabetical arrangement to constitute a geographical directory or gazetteer. We think it would have been a much better plan to describe types of health resorts, based upon the temperature, altitude, humidity, etc., and to indicate in succession the individual resorts which belong under this or that classification, with incidental mention of special features. Such an arrangement would be more suitable for reference, and would be less suggestive of compilation, on the one hand, and of padding on the other. As a mere guide-book the work does not go into detail enough for a work of reference. There is, of course, a vast fund of information in these chapters, but the general impression which one derives is that for medical readers the subject of local health-resorts should be put more tersely,

more in the language of science, leaving information of promiscuous character, to works of a different class.

Under the head of climato-therapeutics much space is given naturally to the climatic treatment of phthisis. Laryngeal tuberculosis requires a climate of itself, a climate free from dust-storms. The patient with this affection must beware alike of the seaboard and of Arizona and New Mexico. High altitudes are contraindicated in febrile cases, and also in patients with emphysema and heart disease. The consensus of opinion is that long sea-voyages are of benefit in phthisis of the first and second stages.

We may state in passing that the section on climato-therapy of phthisis appears to be the work of more than one author. While a portion of the text consists of a mere recital of the vogue of this or that locality for the tuberculous patient, we also encounter paragraphs which deal with general principles. Here we find a classification of climates based on the indications respectively of protection, invigoration, prophylaxis, etc. Thus a protective climate is warm, equable and sheltered, irrespective of altitude; such a combination is found in the United States, in San Antonio, Lakewood, Aiken, Santa Barbara. An invigorating climate must always possess a high altitude, with the exception that the summer months may be passed at northern seaside resorts. Especially mentioned in this connection are the Colorado Rockies, and the high ranges of Mexico and southern California. But a combination of or rather a compromise between a soothing and invigorating climate is indicated in a very large proportion of cases. This indication is filled by the Adirondacks, and Asheville, N. C., with Atlantic City as a seaside equivalent.

A special classification is also given which is based upon the extent and duration of the disease. The subdivisions are as follows:

I. Little or no tendency to limitation of the disease as seen in florid phthisis, quick consumption, etc. Here no climate is of any avail.

II, III. Disease progressive, but liable to arrest. These cases are usually febrile and hence require protection at first, but invigoration later.

IV. Disease progressive in time, but limited in space. Here belong cases of fibroid phthisis, and of limitation to a single lobe. The patients are not much influenced by special climates.

Most of the cases of consumption belong to none of the above divisions. The average case is not severe enough to be included in the first category. while it does not possess that quality of limitation which is present in the other classes.

No general rules can be laid down, but the selection of climate will depend on the individual case.

Atlantic City and Cape May are highly praised for scrofulous and tuberculous children.

The general plan and intent of this system of non-medicinal therapeutics cannot be too highly commended. The same degree of praise may be awarded to the mechanical part of the work, the indexing being especially good.

Atlas of Clinical Medicine.—Jonathan Hutchinson, F. R. S., General Secretary of the New Sydenham Society, has requested Messrs. P. Blakiston's Son & Co., of Philadelphia, the American agents of the Society, to announce the publication of "An Atlas of Clinical Medicine, Surgery and Pathology," selected and arranged with the design to afford, in as complete a manner as possible, aids to diagnosis in all departments of practice. It is proposed to complete the work in five years, in fasciculi form, eight to ten plates issued every three months in connection with the regular publications of the Society. The New Sydenham Society was established in 1858, with the object of publishing essays, monographs and translations of works which could not be otherwise issued. The list of publications numbers upwards of 170 volumes of the greatest scientific value. An effort is now being made to increase the membership, in order to extend its work.

EDITORIAL.

THE EARLY DIAGNOSIS OF PULMONARY TUBERCULOSIS.

As to just what constitutes the early stage of pulmonary tuberculosis there is not yet uniformity of opinion; many writers speak of a pretuberculous stage which obviously can have no existence in fact, for every one must necessarily be in this stage until tuberculous invasion has actually taken place. Others apply the phrase, *early stage of tuberculosis* to that which in reality is the early stage of phthisis or consumption; for example Knight of Boston not long ago made the statement before the American Climatological Association that, "an early diagnosis (pulmonary tuberculosis) is not usually difficult since the discovery of the tubercle bacillus." Such an expression is unfortunate and can but lead to confusion, for it is well known to those who are at all familiar with the pathologic alterations which occur in tuberculous lungs that tubercle bacilli can only appear in the sputum when destructive changes, resulting in the elimination of softened, necrotic tissues, are taking place. Be the area involved large or small the presence of the germ in the expectoration is not associated with incipient alterations, but, on the contrary, with ulceration and cavitation.

If we are to avoid confusion we must clearly distinguish between the *early stage of tuberculosis* and the *early stage of phthisis or consumption.* In the first instance we are dealing with the formation of tubercles, i. e., with the proliferation of active, living cellular elements, whereas in the latter we have to deal with death and destruction *en masse* of these cellular elements and the expulsion of the resulting detritus.

If, therefore, we are to make an early diagnosis in the true sense of the word, we must seek to recognize the disease during the period in which the first invasion of tubercles occurs in the lung and before destructive changes are conditioned or impending. In this stage of the disease the symptoms experienced by the patient, although slight and insufficient, many times, to induce him to consult a physician, are suggestive and should always be taken carefully into consideration. The

recurrence of winter colds and bronchitis, loss of appetite, malaise, digestive disturbances, loss of weight and slight elevations of temperature (90°-100° F.), particularly if accentuated by physical exercise, when not accounted for in an entirely satisfactory manner by other causes, should invariably excite the suspicion of the eruption of tubercle and in all such instances a thorough and painstaking physical examination should at once be instituted.

At this time, however, the eruption of tubercles is not dense enough, the proliferation of connective tissue is not sufficient and the bronchioles and alveoli are not as yet so obstructed as to produce percussion dullness. As a matter of fact the percussion note remains unchanged, except in some instances when it will be found clear and full and in quality almost resembling tympany. Indeed during this period there is so little evidence, if any, to be obtained from percussion that we can practically afford to ignore it as an aid in making a truly early diagnosis.

Certain delicate auscultatory phenomena are nevertheless present and audible to the ear of the practiced diagnostician. Such are weakened or rough inspiration, or both, often associated with an interrupted rhythm. At times, also an extremely delicate apical catarrh may be detected, as evidenced by a slight sense of moisture or *stickiness* which may attain the degree of very fine crepitation. The latter sign may frequently be brought out by making the patient cough, after which it is to be heard at the end of a deep inspiration.

If the auscultatory signs which have been enumerated are found, after repeated examinations at intervals, to persist over a circumscribed area, an apex in an adult for instance, they may be accepted as corroborative evidence of the eruption of tubercles, i. e., of the early stage of pulmonary tuberculosis. Furthermore when the history and subjective symptoms are in accord with the detection of these early physical signs, the diagnosis becomes positive and any additional diagnostic means, as for example the tuberculin test, are entirely superfluous.

There will, however, always be instances in which a reasonable doubt will arise in the mind of even the expert physical diagnostician as to the true nature of the patient's condition. Those less experienced

in auscultation, will, needless to say, more often find themselves unable to determine the diagnosis. It is just in such instances that tuberculin is supreme in confirming or disproving suspicion, and when judiciously and properly administered the tuberculin test will always be found perfectly safe and reliable.

The objections urged that it is prone to excite to activity latent tuberculous processes and thereby do harm, is wholly without foundation, for on the one hand its most bitter opponents have not been able in a single case to demonstrate that such a result has followed, while on the other hand, those who have had the greatest experience in its employment are unanimously agreed that when properly given, no ill effects can occur.

It has been asserted that syphilitics as well as patients suffering with other diseases, have reacted to tuberculin, and this fact has been adduced as evidence that the test is unreliable. But all syphilitics do not react nor do all cancerous subjects for example, and since we know, that syphilis, cancer and many other affections are again and again found to coëxist with tuberculosis in the same individual, all those who are not laboring under preconceived prejudice will see in this an argument *not against*, but *for* the efficacy of the test, inasmuch as in all human probability tuberculosis, although not otherwise demonstrable, is nevertheless concomitant in these patients.

Again the test has been found to fail in patients in whom the diagnosis could be made positively not only by physical examination, but by the microscope, and this experience has caused many to lose faith in the reliability of tuberculin as a diagnostic agent. But why resort to tuberculin when the diagnosis is already certain? It is quite unnecessary, but if for any reason it be done, the seeming failure in such instances is readily to be explained by the fact that when the disease has so far advanced that destructive lesions (although possibly of very limited extent and not necessarily demonstrable on auscultation) are present, the patient has, from the gradual absorption of specific toxins of the germ from caseous or necrotic foci, in so far acquired a toleration, that the minute amount of toxins contained in the test dose proves inert. Just as when toleration has been established to five or

ten grains of morphine per day and intoxication can not be produced with smaller doses, so it is in the case of the tubercle toxins. The more incipient the tuberculous process existing, the less the toleration, and the smaller will be the dose of specific toxins required to induce a reaction, and conversely the further pathologic changes have progressed, the greater is the toleration, and the larger will be the dose necessary to produce the typical effect.

Tuberculin diagnosis is, however, not a matter of mechanical simplicity; if it were less often so considered, by many who have failed to apply it intelligently, and have therefore been disappointed in it, and if such men would give to this subject the careful thought and study which they afford as a matter of course to other subjects in medicine, no one would have just cause to oppose a remedy which when properly employed is capable of confirming every doubtful diagnosis of tuberculosis, not only with all safety, but with absolute exactness.

THE AMERICAN CONGRESS FOR TUBERCULOSIS.

The Third Annual Meeting of this Congress will take place on May 14, 15, and 16, at the Hotel Majestic, New York City, under the auspices of the New York Medico Legal Society.

Although having had a comparatively small beginning in 1900, the appreciation of this movement by the profession was well attested by the participation last year of a large number of the leaders in the crusade against tuberculosis, and we have no doubt that the forthcoming third meeting will do much to extend the influence of the Congress in furthering the successful prophylaxis and the establishment of State institutions for the care and treatment of tuberculous patients.

Much credit and praise is due to the President of the Medico Legal Society, Mr. Clark Bell, for his devotion to and for his indefatigable labors in connection with the previous assemblies, and we take this opportunity to urge all interested workers to participate in the forthcoming Congress.

PATHOLOGIC EXHIBIT AMERICAN MEDICAL ASSOCIATION.

The Committee on Pathologic Exhibits for the American Medical Association is anxious to secure materials for the coming session at Saratoga, June 10th to 13th, inclusive.

Pathologic specimens, as well as specimens illustrative of the allied fields of bacteriology, physiology and biology are desired; also exhibits of new apparatus, charts, etc., used by teachers of pathology and physiology in medical colleges.

This exhibit has already become a permanent feature of the annual sessions of the Association and to enhance the value of the work it is suggested that as far as possible each contributor select materials illustrative of one classification. Those lending specimens may feel assured that good care will be afforded them, and due credit will be given in the published reports. They should be addressed to any one of the committee, as follows: F. M. Jeffries, 214 E. 34th St., New York City; W. A. Evans, 103 State St., Suite 1403, Chicago, Ill.; Roger G. Perkins, Western Reserve Medical School, Cleveland, Ohio.

A PRIZE ESSAY.

It is desired to direct the attention of the profession to the generous offer of the Maltine Company of Brooklyn, N. Y., (see advertising page IX), of a first prize of one thousand and a second prize of five hundred dollars for the best essays on Preventive Medicine.

It is particularly specified in the conditions governing the competition that Maltine or any of its combinations must not be mentioned or even indirectly alluded to in the essays.

Drs. Daniel Lewis, of New York, Charles A. L. Reed, of Cincinnati, and John Edwin Rhodes, of Chicago, have consented to act as judges.

The high professional standing of these gentlemen gives ample assurance that the prizes will be awarded to the essays presenting the greatest merit.

SUPPLEMENT TO THE JOURNAL OF TUBERCULOSIS.

In this part the whole subject of Pulmonary Tuberculosis will be covered by a continued series of articles written by Dr. Karl von Ruck to appear in the following order:

Article I —The Cause of Tuberculosis, and The Conditions Which Predispose to its Acquirement. Article II.—The Prevention of Tuberculosis. Article III.—The Pathology and Symptomatology of Pulmonary Tuberculosis. Article IV.—The Diagnosis of Pulmonary Tuberculosis. Article V.—The Prognosis of Pulmonary Tuberculosis. Article VI.—The Treatment of Tuberculosis, Dietetic, Hygienic and Symptomatic. Article VII.—The Climatic Treatment. Article VIII.—The Specific Treatment. Article IX.—Laryngeal Tuberculosis, its Diagnosis and Treatment. Article X.—Institutions for the Treatment of Pulmonary Tuberculosis.

THE SYMPTOMATIC TREATMENT OF TUBERCULOSIS.

[Continued from Page 104.]

THE TREATMENT OF PNEUMO-THORAX.

This is, as a rule, sympomatic only, especially when it occurs in the closing stage of phthisis. The patient naturally assumes the most favorable position, lying or leaning on the affected side which enables him to obtain all the air that is possible. If the pain is severe, a hypodermic injection of morphine should be given, and syptoms of collapse should be met by diffusible stimulants, external application of heat, etc., while great dyspnoea may be moderated by the inhalation of oxygen.

In cases where the heart becomes greatly displaced and when there is decided bulging of the inter-costal spaces on the affected side, the probability exists that there is no free communication between the point of rupture and the pleural cavity, and that the air forced into the pleural cavity with violent inspiratory efforts, cannot return through the perforation owing to its compression, or to a valve-like slit in the pleura. Under such conditions a fine trocar and canula should be introduced, when if the theory proves correct, the pressure will become equalized by the escape of air. After the immediate danger is averted, the further treatment resolves itself into that of the usually resulting acute pleurisy which eventually requires drainage, if the exudate is purulent which is almost always the case.

In circumscribed pneumo-thorax, the symptoms are not so urgent, and many cases go unrecognized upon the assumption that simple pleural inflammation is responsible for the symptoms.

THE TREATMENT OF NIGHT-SWEATS.

The night-sweats of phthisis occur as a rule in connection with caseous softening and suppuration, and although, especially in the early statges, we may fail to demonstrate such processes by physical examination, the attendant fever and subsequent manifestations will often confirm this view. The sweats are therefore symptomatic of pathological changes over which we cannot exert direct control. However, inasmuch as this symptom stands very intimately in relation to the fever or rather to its decline, we can influence the occurrence and degree of the sweat by measures which moderate or control the fever. We should therefore endeavor to diminish the fever by rest, by open air treatment in the milder forms, by regulation of diet and by hydropathic measures in cases in which the application of cold water is not contraindicated by the general condition of the patient.

Nightsweats are not a troublesome symptom with my patients, and even the far advanced cases which present those conditions under which the sweating is most commonly observed, lose their night-sweats soon after admission to the Institution. The necessity for prescribing directly for them is very rare indeed, the amelioration and control of this as of any other symptom depending primarily upon correct general management.

When direct interference becomes necessary we may have recourse to the administration of drugs or to applications to the skin, and I would advise against the use of drugs until the other simpler and more desirable measures have failed. I would recommend first a trial of bathing the trunk with salt water, or with vinegar and water, or of giving the patient an alcohol rub just before going to sleep, at which time a glass of milk with brandy or whiskey may be taken. I have occasionally had satisfactory results from the application to the chest of a compress wrung out of a strong salt solution and allowed to remain in place all night.

If these means prove ineffectual, we may resort to internal medication. In patients who are weak and exhausted camphoric acid may be tried in doses of 15 to 20 grains; it should be continued for a week or more before being discarded as inefficient.

Should this fail or cease to exert an influence agaricin may be given, beginning with 1-10 gr. in pill-form three or four hours before

retiring. This dose can be slowly increased, as may become necessary, to one grain, but like other remedies for night-sweats it gradually loses its effect.

Much more popular is atropine, but in effective doses it so often interferes with all other secretions, and its action is so prolonged that even the patient will at times ask to be excused, preferring the sweating to the disagreeable after-effects of the drug. In occasional instances, I have secured absolute control of the sweats with very minute doses (1-200 gr. hypodermically).

Oxide of zinc, 2 to 3 grains in pill-form, extract of nux vomica, chloralamid or sulphonal have at times been found to act favorably. A trial of the latter would naturally suggest itself in the event of coëxistant insomnia.

Ergot has also been warmly recommended by Goldendach[1] whose idea was to employ a remedy to which is attributed the ability of exerting an influence upon the nerves and through them upon the sweat secretion. Before going to sleep, pulv. secalis cornuti, 5 to 10 grains should be given. In consideration of the important rôle which the vaso-motor nerves play in the process of secretion this seems by no means an irrational procedure, and may be deemed worthy of a trial.

More recently H. Hirschfeld[2] reported favorable experiences in night-sweats, from painting the skin with equal parts of formalin and alcohol. In the cases in which I have so employed formalin in varying strength, from 2 per cent. to 20 per cent., the results were not satisfactory. With strong solutions the irritating vapors from the formalin are a source of great annoyance, but Hirschfeld has met the objection in his method of application which is as follows: In order to obviate the ill-effects upon the respiratory mucosa and the eyes from the rising vapors, the patient's shirt must be kept on during the procedure. In addition, a piece of rubber cloth about a yard square is placed around the patient's neck in such a manner that it covers the chest and extends around the sides of the trunk, overlapping at the upper part of the back. The rubber cloth is held tightly in place by an ordinary cloth in the form of a cravat. With the patient sitting up in bed the shirt and rubber cloth are lifted and the back is painted. Next with the patient in the dorsal position the shirt and rubber cloth are reflected over the head and the application made to the chest and abdomen. After replacing the shirt and rubber cloth over the body

[1] *Deutsche Med. Woch.*, 1894, S. 551.

[2] *Berliner Klin. Woch.*, No. 15, 1900.

of the patient the latter is covered and must remain so for an hour before removing the rubber cloth. The author states that one painting suffices for from 8 days to 4 weeks. In severe cases when the sweats return the painting must be repeated. Some burning and itching of the skin often results and sometimes a slight scaling of the epidermis is said to follow.

Instead of formalin Strassburger[1] reports excellent results from applications of tannoform, a condensation product of tannin and formaldehyde. One part of tannoform is mixed with two parts of talcum venetum, and the mixture is applied to the skin as a dusting powder. Strassburger asserts that it is equally as effective as formalin, is much simpler in application and possesses the additional advantage that the patient himself may be entrusted with it. The effect can be augmented by rubbing the powder into the skin.

The formalin probably owes its effect to a blocking of the glandular ducts by epithelial debris consequent upon the inflammation induced by it, and is entirely mechanical in its action. As regards the tannoform a similar effect is produced by the contained formaldehyde which is increased by the astringent action of the tannin.

In some of my cases in which I have succeeded in controlling the sweats, I have observed that the fever became more pronounced either by reaching higher degrees or by lasting longer.

At best the treatment of night-sweats is but a temporizing measure, and inasmuch as the loss consists almost entirely of water which is easily replaced, the control of the symptom is more a question of enhancing the patient's comfort than of exerting any appreciable influence upon the course of his disease. Attention has already been directed to the fact that night-sweats are usually associated with caseous softening and suppuration. When the absorption of fever-producing substances from foci the seat of such changes, has sufficiently diminished or has ceased, the sweats will disappear.

THE TREATMENT OF ANAEMIA.

Most patients who suffer from pulmonary tuberculosis in any stage, show evidence of more or less pronounced anaemia. The haemoglobin is deficient in the great majority of cases coming under my care. In 100 consecutive records of the blood state of patients on admission into the Winyah Sanitarium there is not a single instance in which the haemoglobin-percentage reached one hundred, even when the count of red cells was normal or above. I find, however, that

[1] *Therapeutische Montashefte*, March, 1901.

slighter deficiency is often noted in blood examinations of persons who are in apparent good health, and I have therefore accepted as showing normal values all those records in which the percentage approximated 85 per cent. for men, and 80 per cent. for women. In the count of erythrocytes an approximation to five millions for men and four and a half millions for women sufficed to exclude from the cases here recorded as deficient. Neither were such cases subjected to any special treatment, unless further deterioration became evident upon subsequent examination, which rarely happened; on the contrary, improvement occurred quite uniformly under the general dietetic and hygienic methods and other appropriate treatment which the patients received.

An analysis of these records shows the following results:

Approximating normal values in red cells and haemoglobin, 17 per cent.

Approximating normal values in red cells with marked deficiency in haemoglobin, 41 per cent.

Marked deficiency in red cells and in haemoglobin, 40 per cent.

Approximating normal values in red cells and haemoglobin, 17 red cells, 2 per cent.

The lowest count in red cells was 3,048,000 and the lowest percentage in haemoglobin, 40.

We find therefore that haemoglobin was deficient in 81 per cent. and that the count of erythrocytes was markedly short in 42 per cent.; a comparison with prior records shows that these values are practically correct for a larger number of cases as well.

The results from treatment of these cases was satisfactory in all those in which the stage of the disease and the attending general nutrition and complications justified such an outcome. Nothing was accomplished in instances in which extensive destructive processes and suppuration or the presence of complications (intestinal tuberculosis or amyloid disease) conditioned an adverse termination.

The treatment of anaemia in tuberculosis is practically the same as of other symptomatic forms of anaemia. In all those instances in which the tuberculous disease had progressed to such a degree that there was no reasonable prospect for improvement or recovery, no treatment was attempted, the patients being returned to their respective homes. In other instances the successful removal of gastric catarrh and atony or other gastro-intestinal complications, was alone sufficient to improve the general nutrition and with it the anaemic

state, but the administration of ferruginous remedies contributed visibly to a more rapid increase of the haemoglobin especially. There was, however, a large percentage of cases in which direct treatment of the anaemia became necessary, and which showed material improvement only upon its adoption, although the dietetic and hygienic methods were systematically carried out, and increase in weight had also occurred. The benefit of treatment was then not only apparent from the increase of haemoglobin and erythroctyes, but also from the improvement of the patient's strength and endurance, and by the return of a better color of the skin and visible mucous membranes.

In the choice of the particular preparations, I have no doubt that iron in any form will accomplish the object sought, so long as it is given in sufficient quantity in a form that is well borne by the digestive organs, and when the latter are normal or approximately so in their functions. The necessity of maintaining their integrity and of adding nothing that may in any manner increase any existing deficiency in the digestive process demands the adoption of a preparation which shall be free from irritating or astringent effect, and of one which conveys the iron in an organic rather than an inorganic state. Upon this indication I have continued to use Pepto-mangan (Gude) ever since my first investigation of it in 1894.[1] This preparation has proven uniform and satisfactory in all respects in its acceptability to the stomach, and in the accomplishment of all that can be reasonably expected, but especially in the increase of the haemoglobin per cent.

Since its introduction numerous preparations of a like character have been placed upon the market, which have attained more or less recognition and testify to the advantage of administering iron or iron and manganese in a soluble and readily available form.

In this connection I desire to call attention to the Glycerine Extract of Red Bone Marrow, made by Armour and Co., to whom I suggested its preparation in the first place, in 1895, by having them prepare it for me for experimental use. I found then and have been able to confirm ever since, that this product has a marked influence for augmenting the blood state, especially the red and white blood cells, and that it is otherwise a powerful stimulant to the general nutrition.

The use of arsenic or its combination with iron I have seen no occasion to adopt, as a general procedure in the treatment of the symptomatic form of anaemia as we meet it in pulmonary and other

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[1] Pepto-mangan for Anaemia in Pulmonary Tuberculosis, *New York Medical Jonrnal*, Dec. 15, 1894.

forms of tuberculosis. Its benefits in essential and pernicious forms have been repeatedly asserted and demonstrated, and in a very few obstinate cases it has appeared to facilitate the improvement. In such cases, however, I prefer now a combination of Peptomangan with Glycerine Extract of Red Bone Marrow, as much less liable to upset the digestive organs.

Whatever form or combination of iron may be prescribed in tuberculous anaemia, a properly selected and adjusted diet and judicious general management in hygiene and in securing fresh air and sunlight are essential to the best results; they succeed in mild cases without other aids and are indispensable in other respects as well, to the cure of the patient.

THE MEDICINAL TREATMENT OF PULMONARY TUBERCULOSIS.

Under this head I propose to consider the utility of remedies which are prescribed more particularly for their influence upon the disease itself, remedies having for their object "the change of soil," that is, the increase of the patient's resistance to the disease. "Change of soil" is aimed at by the application of dietetic and hygienic methods which I have already considered, and in a measure also by climatic treatment which will be discussed in a subsequent chapter.

Here I wish to deal especially with the use of certain drugs given for the purpose of supplying supposed deficiencies in the chemical composition of the fluids and tissues, for their general stimulative effect upon metabolism or again for their alterative effect.

That deficiencies in the chemical constituents of the body manifest themselves in connection with disease is a well established fact; and scurvy, rickets, osteomalacia and anaemia are familiar examples. Further, that excesses of, or retention of certain chemical constituents may give rise to organic and functional disturbances as in gout or the so-called arthritic-diathesis, is not subject to dispute. When the existence of such conditions can be demonstrated by physical and chemical examinations there is no obscurity as to the object of treatment to be pursued. In tuberculosis, however, such physical and chemical demonstrations are not so readily made, and in many instances they are impossible. We are therefore greatly dependent upon clinical data and, excepting the iron preparations the effect of which we can control, we must reason backward and seek to explain the results that we observe from more empirical medication, by the known chemic and physiologic effects of the remedy to which the result appears to stand in relation.

The clinical value of salts of lime, iodine and iron in glandular

forms of tuberculosis rests upon such a foundation, and in the pulmonary form of the affection these remedies have also proved of value sufficiently often and over long enough periods of time that the factor of coincidence may be excluded.

The hypophosphites were first introduced upon the theory of supplying mineral constituents, as well as phosphorus as an available nerve-food and a stimulant to the metabolic processes, and they have often proved their value not only in tuberculosis, but in other wasting diseases also. Fellows' Compound Syrup of the Hypophosphites, for instance, has been before the profession for so many years and has attained so wide a reputation in the treatment of tuberculosis in this and in all other civilized countries, that the favor with which it is regarded cannot be explained otherwise than upon its merits. As much may be said of Churchill's and of McArthur's syrup, likewise of the lacto-phosphates and wheat phosphates and of more recent products like the glycero-phosphates, which, as they are made from glycerino-phosphoric acid, furnish an ideal nerve-food in the form of physiologic phosphorus at once available to the system.

While the combination with calcium, potassium, iodine, iron and manganese, etc., can serve the organism in special ways, I believe it is the effect of phosphorus upon tissue-metabolism which makes these products most valuable in the treatment of tuberculous and scrofulous affections. From my own experience with a large clinical material of this class, I have reason to express my faith in the value of these preparations in cases in which the disease has not induced an irreparable state of exhaustion. It is, indeed, to be remembered with these as with all other remedies that a trial should not be made with patients whose condition is hopeless and in whom everything else has failed. Neither should we expect immediate results, especially in the active and febrile stage, during which losses are difficult and sometimes impossible to prevent. My best and most convincing results have been in cases with little or no fever, without complications, especially on the part of the digestive organs, and when the patient was stationary or was losing but slightly in his weight and strength, in spite of the fact that food in sufficient amount or in excess was taken and was apparently digested.

Iodine in combination with chloride of gold subcutaneously, was warmly recommended by Gibbs and Shurley[1] about ten years ago, and the pure tincture of iodine was used in like manner and by deep injections into the tuberculous portions of the lungs years before by

[1] *Therapeutic Gazette*, April 15, 1901.

various clinicians and by myself. More or less frequently recommendations of the subcutaneous use of iodine preparations are found in medical literature.

Ingraham[1] offers a formula containing iodine 1-4 gr., bromine 1-4 gr., phosphorus 1-100 gr., thymol and menthol, of each 2-3 grains, in one drachm of sterilized oil, but reports the clinical history of only one case to illustrate its curative effect.

Croftan[2] used Iodipin (10 per cent. iodine in sesame oil) as less irritative, and saw uniform improvement in twenty-seven cases treated. Lawrence Flick has long insisted upon the use of iodine compounds by inunction, using iodoform and more recently europhen for that purpose with satisfactory results. Iodol has been rejected by Flick[3] as decomposing too rapidly and becoming useless before the patient can apply it, and Tyson's[4] results with this preparation seem to justify Flick's views.

S. Solis Cohen[5] believes iodoform innunctions to have no material advantage over the internal administration of the drug. He recommends a gradual increase in dosage to 5 gr. three times a day, especially in the early stages before destructive processes have occurred.

Russell[6] in a series of 123 cases treated with iodoform internally in doses of 15 to 30 grains per day, found that these patients gained more in weight than did others who received the same care but were given no iodoform.

Otis[7] quotes Ransome who says that europhen is one of the best remedies that can be given to assist in the nutrition of the patient and to alleviate cough.

A more effective method of exhibiting iodine in the treatment of pulmonary tuberculosis, claimed by Cavvazani and Spadoni,[8] consists of the internal administration of iodides, coincidentally with inhalations of spirits of turpentine, which latter they found to cause the liberation of nascent iodine in the lung which they say exerts a specific influence upon the tubercle bacillus and its products.

[TO BE CONTINUED.]

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[1] *Med. Record*, Vol. 54, page 483.

[2] *Journal American Medical Association*, Nov. 17, 1900, page 1273.

[3] *Journal of Tuberculosis*, Vol. III, page 116.

[4] Ibid, page 12.

[5] *Journal Am. Med. Association*, Vol. 36, p. 848.

[6] *Birmingham Med. Review*, June, 1898.

[7] *Boston Med. and Surgical Journal*, July 21, 1898.

[8] *Riforma Medica*, Sept. 2, 1901.

THE JOURNAL OF TUBERCULOSIS

VOL. IV JULY, 1902 No. 3

ORIGINAL CONTRIBUTIONS.

INTRATRACHEAL INJECTIONS IN PHTHISIS PULMONALIS.

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The object of this paper is to briefly call attention to a method of treating pulmonary phthisis that has not, in the opinion of the writer, received the attention it deserves. Intratracheal medication in chronic pulmonary affections does not in any way interfere with other methods of treatment and can be employed in addition to such dietetic, climatic. and medicinal means as may be best suited for an individual case. Like other means at our disposal, it finds its greatest usefulness in the first and second stages, but many of the symptoms in the advanced cases are also relieved by this method.

The writer has not always been able to confirm his diagnosis of tuberculosis by finding the tubercle bacilli in the sputum, as many have been seen in the early stages where the physical signs revealed but a small involvement of the lungs, and where the amount of sputum expectorated was scanty. The fact that some of the inflammatory cases, as, for instance those following pneumonia, run their course without the tubercle bacilli being found in the sputum during life, or in the tissues after death, has lead competent observers to recognize a tuberculous and a non-tuberculous form of phthisis pulmonalis. Whether we accept this division as correct or not, the practical fact is that we find cases

with a clear clinical picture of beginning phthisis in which repeated examinations fail to discover the germ. If we find a few germs once or twice after a number of examinations we must not forget that they may be accidentally present, as a great variety of pathogenic organisms may be found in the mouth of a healthy subject.

We are justified in diagnosing beginning phthisis when our patient gives a history of impairment of nutrition with loss of weight and a hacking cough, if we find evidence of involvement of one apex and a slight rise in the afternoon temperature, even though the physical signs are not marked. If the tubercle bacillus is found at each examination of the sputum our diagnosis is confirmed, but unfortunately the presence of the organism is not one of the first signs.

We know that a patient may have small tuberculous foci in the lungs that give rise to few or no symptoms; but let the patient catch cold, or contract pneumonia, and the secondary infection will set up a train of serious symptoms. This secondary infection is becoming to be more and more recognized as an important factor in the course, prognosis and treatment of pulmonary phthisis. In the treatment of the disease these secondary infections demand our closest attention, and in proportion as we are able to ward off bronchitis, pneumonic extensions and the like, we are in a position to combat the tuberculous trouble. It is in these secondary infections that intratracheal injections find their greatest usefulness, by keeping the bronchial tract in as healthy a condition as possible. The tuberculous process itself seems in many cases to be favorably influenced by the injections.

The introduction of a considerable quantity of fluid into the trachea, by means of a suitably curved syringe, passed between the cords, appeals to one as a rational means of local medication. The objection has been raised by many that it causes so much irritation and such severe coughing as to render the procedure dangerous. The trouble has been that too irritating fluids have been used, or unskillfully introduced. The writer has given hundreds of these injections, and only in a very few instances has severe coughing, either directly or indirectly, been caused by them. There are many in whose trachea one or two drachms can be introduced with hardly a cough or sense of suffocation.

Many observers who have discarded the method, because of the irritation produced, used watery or glycerine solutions, which are decidedly irritating when introduced into the trachea. If pure olive oil is used as a vehicle, and reasonable care is taken to select drugs not

too irritating to the mucous membrane, no trouble will be experienced. The Muir tracheal syringe is the one used by the writer. I will quote the following from a former paper:[1]

"The technique is similar to that of laryngeal applications. The patient should hold his tongue out while the operator introduces the cannula of the syringe, guided by the mirror, during a deep inspiration. If the patient inhales gradually, slowly and steadily, the cannula can be introduced between the vocal cords, and from one to two drachms injected without inconvenience. The operator should introduce the fluid gradually and steadily, not in spurts, and the whole amount must be introduced before the end of the inspiration, otherwise choking will take place."

This method has been used both in private and dispensary practice with good results. It is difficult to give the precise value of the method in any given case, as other means were employed. Many of the dispensary patients were under poor sanitary surroundings and had to earn a living while undergoing treatment. Some were lost sight of before the value of the treatment could be ascertained.

In estimating the value of the method, in connection with other means, one must use it in a number of cases. It is not claimed that this is a specific in any sense of the word; it simply relieves certain conditions and places our patient in a position to better resist the inroads of the disease. It would be unprofitable to give a detailed history of a number of cases under treatment during the past two years. More can be gained by indicating certain results obtained by its use and by illustrating a few by reference to certain cases.

In the early stages, where but a small area is involved and the temperature is only slightly raised above the normal, it will give relief in many cases, gradually bring the temperature back to normal, lessen the cough and expectoration. This has been noted in cases where the other medication directed to the improvement of the general condition could hardly account for the steady improvement. One case, a young man, slender in build, came under observation with the history of a hacking cough, loss of weight, mucous expectoration and an evening temperature of about 100°. At the right apex was found slight dullness, jerky inspiration and a prolongation of expiration with a slight increase in pitch. Intratracheal injections were used for a number of months, together with pulmonary exercise and tonic treatment. The

[1] Intratracheal Injections in Bronchial and Pulmonary Affections; *Medical News*, Sept. 28, 1901.

temperature gradually went down to normal, the expectoration lessened, the area of dullness diminished, and the chest expansion increased. The hacking cough did not entirely disappear, nor did he gain much in weight, although his appetite improved. He was confined in a store during the whole day. On the approach of cold weather last fall he was urged to go west, which he did. He is now in Denver, Colorado, and has gained twenty pounds in weight and feels perfectly well. This case is a satisfactory one when we consider that he went through a Michigan winter without intercurrent attacks of bronchitis and that actual improvement occurred despite unsatisfactory surroundings.

It is in the cases more advanced than this that we see the beneficial results which we can attribute directly to the injections. Where the cough is severe and the muco-purulent expectoration is marked, with the hectic condition present indicative of septic poisoning, we find much relief from the regular use of the injections. The cough lessens, the muco-purulent matter is more easily expelled and soon decreases in amount. As these symptoms decrease the temperature approaches normal.

There is, occasionally, a case where the injection seems to cause irritation, either at the time of its use or several hours afterwards. As a rule we may expect irritation in proportion as the mucous membrane is acutely congested. This was first noticed in treating the congestive stage of acute bronchitis. In phthisis where the mucous membrane is acutely congested by the accompanying bronchitis or harassing cough, we may not be able to use the injections until the cough and congestion are controlled by other means. In these sensitive cases, if a spray of cocaine is used before the injection less trouble will be experienced, especially if at first a small amount of the injection is used.

In those cases where laryngeal tuberculosis complicates the pulmonary affection much relief will result by their use, although some difficulty may be experienced on account of the sensitiveness of the parts. Very little permanent benefit can be expected from the method in tuberculous laryngitis, although the temporary benefit is so satisfactory that we are warranted in using it.

The dyspnoea of phthisis is greatly lessened by the injections. This, of course, would not apply to the late stage where the lungs are badly disorganized. The lessening of the dyspnoea seems to be due to the sedative effect upon the nerve terminals of the bronchial mucous membrane. The relief after an injection is noticed within a few

minutes, and usually continues from twelve to twenty-four hours. A patient now under observation says that he is very short of breath on his way to the clinic, but after the injection he feels an almost immediate relief, enabling him to walk faster after having the treatment. The beneficial effect in this case lasts the remainder of the day. The injections have also lessened his cough and expectoration.

The shifting pains and sense of oppression in the chest are usually relieved by the injections. The patients report that their chests feel easier after the injections and they welcome them if for no other reason than for the temporary relief.

One patient came to the clinic last September with the history of loss in weight, cough, pain across chest, afternoon fever, chills and night sweats. Examination revealed morning temperature 100°, dullness over both apices, with bronchial breathing and a few mucous râles. Intratracheal injections were used every day at first, then every other day. The cough, dyspnoea and pains in the chest gradually lessened, the chills and night sweats disappeared entirely. The temperature approached normal, but while under observation there was almost always a slight rise. The dullness of the upper right side cleared up entirely, but a small dull area remained at the upper left, with slight bronchial breathing. The general condition improved and the patient often said that she felt decided relief from the sense of oppression across the chest after the treatments. The other medication was largely tonic in its nature, directed towards improving her general nutrition. Creosote was given for a short time. The latter part of last December she left Michigan for New Mexico, and a month after arriving reported that she had continued to gain. The improvement in this case would seem to be due largely to the injections, as evidenced by the improvement in the physical signs and her own subjective sensations.

The writer has used only a limited number of drugs in these injections. Olive oil is the only vehicle used. The formula used in the majority of the injections was liquid guaiacol, 2 per cent., and camphor-menthol (equal parts of camphor and menthol) 5 per cent. This seldom causes irritation, is not unpleasant, and has been the most generally useful of the formulae tried. Ichthyol, 2 per cent. with camphor-menthol, 5 per cent. has also been used. It seems to lessen the secretions. It is not as agreeable for the patient and has not proven in the majority of cases as useful as the first formula.

Iodoform, 1 to 2 per cent. has been used. It does not dissolve readily in the oil. A little less than 2 per cent. will be taken up by the oil.

Iodoform is generally regarded as a valuable agent in all forms of tuberculous disease, so it would seem that it would be especially useful in this connection, but a more extended trial is necessary in order to know its value as compared with the other combinations.

The solution should be sterilized before it is used. This can be done easily by placing the bottle in a hot water bath for forty-five minutes.

The usefulness of these injections in chronic pulmonary infections has been so evident in a number of cases that one is justified in giving them a more extended trial.

912 Chamber of Commerce.

EPIDEMIC INFLUENZA CONSIDERED IN RELATION TO QUARANTINE AGAINST TUBERCULOSIS.

BY A. J. COMSTOCK, M. D., VENTURA, CALIFORNIA.

Most physicians in active practice realize the serious bearing of attacks of influenza upon the subsequent development of pulmonary tuberculosis. I have never forgotten the words of the late Dr. J. M. Da Costa, who, as professor of the practice of medicine in the Jefferson Medical College of Philadelphia, as early as 1882, thus began his lecture upon epidemic influenza:

"Gentlemen: I will now speak concerning the least fatal, and at the same time the most fatal epidemic disease at present prevalent upon our continent. I refer to epidemic influenza. It is least fatal in its immediate results, but most fatal in its far reaching mortality."

But while those words have been in my memory through eighteen years of practice, in this paper I will only consider the relation of epidemic influenza to the subsequent development of pulmonary tuberculosis. When we refer to our carefully kept records, or recall to mind the cases of phthisis coming to us from day to day for treatment, we find that not less than ninety per cent. of the patients have to make statements something like this: "My present trouble followed an attack of La Grippe;"—and this attack may have occurred, in any given instance, one, two, or even fifteen years before.

There was a time when influenza was not the scourge that it is to-day. Formerly this disease, at least in epidemic form, made its appearance in cycles, often with intervals of ten years between its

recurrences, but now it seems ever prevalent. This may perhaps be accounted for by the enormous increase in commerce and travel in modern times. It is a fact that if influenza becomes epidemic in New York, cases will surely occur at Chicago within the week, and at San Francisco within a few weeks later, and we have all seen this epidemic girdle the world in startlingly short time within recent years.

Now, it cannot be denied, I think, that pulmonary tuberculosis has steadily gained ground in the United States within the past twenty years. It is still gaining ground. Then what relation does epidemic influenza bear to this increase in tuberculosis? I claim that its causative relation has not been fully appreciated.

The influenza bacillus is a pioneer in a bacterial strife against human life. It leads the way, it cuts the trails, and makes it comparatively easy for the tubercle bacillus to follow and firmly establish itself. We know that the tubercle bacillus is not a specially virulent microorganism to the average human being, placed amidst favorable surroundings. Healthy tissues fight it off for years and often conquer it altogether, but in the system already weakened by the ravages of the influenza bacillus it finds ready lodgment with lessened tissue resistance.

If these things, then, are true, what is implied as to prophylaxis and far reaching sanitary measures? Should we not, in the beginning, isolate influenza patients, as far as practicable? For the patient's own welfare he should be confined to his room and bed from the time that the nature of his disease is discovered, and there detained until all active symptoms have subsided. This course will not only secure the immediate welfare of the patient, but will tend to curtail a probable cause for the spread of tuberculosis in years to follow, as neglect of a case of influenza may afterwards result in the development and spread of pulmonary tuberculosis.

In brief, the logic of the position is this: When considering those infectious diseases requiring the enforcement of a quarantine in the interest of the health of the community, should we not wisely go back to first causes? I do not set myself against the quarantine of any scourge in the nature of disease, but why should we so set ourselves upon the quarantine of the fully developed case of pulmonary tuberculosis, which disease is after all but mildly infectious, and permit the disease which most actively disseminates tuberculosis, epidemic influenza to-wit, to go without any check whatever? Let us begin our reform at the beginning.

THE RELATION OF SCROFULA TO TUBERCULOSIS.

BY CAROLUS M. COBB, M. D., BOSTON, MASS.

The relation of scrofula to tuberculosis is a question of the utmost importance, not alone because it is important to recognize each and every manifestation of tuberculosis, but because it is equally important to recognize other diseased conditions which may be included under the general classification of scrofula. The definition of scrofula is a very loose one, and while it does not cover as many diseases as formerly, it is still used to describe many conditions which evidently do not have a common origin. It is generally accepted that scrofula is tuberculosis of the glands, and almost every case in which the glands are the site of chronic inflammation, especially in children, is called scrofula. This diagnosis is confirmed if the child is anaemic, and such children generally are. The too ready acceptance of this diagnosis leads us to overlook obvious sources of infection that are not tuberculous, and if these sources are unrecognized and untreated the adenitis is likely to continue and to make the typical picture of scrofula. Cervical adenitis is the most common form of gland disease that goes under the name of scrofula, and it is in this region that the unhealed sinuses and suppuration extending over years, make the typical picture of scrofula. If all or even a large proportion of the cases of cervical adenitis are due to tuberculous infection, it is certainly remarkable that these patients do not oftener suffer from general tuberculosis, and it is notable that they do not. This is the more remarkable when we consider the vascular and lymph system of this region and the short distance that infection has to travel before it gains entrance to the general circulation. This is in marked contrast to the action of tuberculous lesions in other parts of the body, and it is a well-known fact that patients with tuberculous disease of the long bones are in much greater danger of general tuberculosis than are patients with cervical adenitis. Another interesting point is that patients with typical tuberculous lesions very rarely have involvement of the cervical glands. This is only one link in the chain of evidence, however much it may be worth, that many of the cases of so-called scrofula are not of tuberculous origin. But if not tuberculous how then explain the group of symptoms which goes under the name of scrofula? There are, evidently, several groups of diseased conditions which go under this general classification. The first of these groups, not in relative frequency, but in clinical importance, is composed of

cases of inherited or intra-uterine syphilis. Every one, of course, recognizes the well marked cases, but it is evident to every one who does much hospital work that there are many cases which are not distinctive enough to attract attention during their early stages. Hereditary syphilis does not cause a general adenopathy, but the glands in the tissues surrounding any local lesion are quickly involved, and in addition to the inhibitory effect which the disease has over general development, the tissues as a whole offer less resistance to infection of other kinds. Syphilis in its various forms offers an explanation of a large class of these cases, but with all of its protean forms it is not so important a factor in the production of scrofula as unhygienic surroundings which lead to all forms of septic infection. While it is undoubtedly true that tuberculosis is a disease of the masses and causes more deaths than any other one disease, it is not so prevalent among the poorer classes as septic infection, although the sepsis is not often severe enough to cause death. Septic infection manifests itself in affections of the skin, as skin disease, boils, ulcers, and infected wounds, and by what is even more common, the so-called catarrhal inflammation of the upper respiratory tract. Enlarged tonsils, adenoid vegetations in the pharynx, and a purulent or muco-purulent discharge from the nose are present in almost every child living in the unhygienic surroundings of the city. With all these forms of infection the surrounding glands are involved, and if the source of infection is chronic, the gland disease will run a protracted course. That inflammation of the nose and throat is a potent cause of enlarged cervical glands, every one can verify for himself. The clinics of the city hospitals show a large increase of these cases of cervical adenitis during the winter and spring months, at the time when the catarrhal conditions are more prevalent, and they also show that they get better as the warm weather comes on, and the child gets better surroundings. Yet these cases are diagnosed as scrofula and hardly any attempt is ever made to find the source of infection. In addition to the general catarrhal condition of the upper respiratory tract, we should also look for local lesions in the mouth, throat, particularly in and around the tonsils, the nose, the ears and upon the surface of the skin in the drainage area of the glands involved. So far as my observation goes infection takes place with the lymph current and rarely, if ever, against it, so that we should look for the source of infection towards the periphery of the lymph system of the glands involved. Lastly, in relative frequency, so far as my experience goes, we find tuberculous infection as a cause of so-called scrofula. Tuberculous disease of the

glands is a much more serious condition than most of the cases of scrofula, and is accompanied by rather serious disturbances of the general health. The patients, either with or without rise of temperature, suffer from loss of appetite, languor, anaemia, and rapid loss of weight. If the disease remains localized the symptoms gradually improve and the affected glands either break down or undergo partial resolution. Under the most favorable termination, there is often a thickened condition of the glands which can be felt for a long time after the storm has passed. The treatment of scrofula should be based upon the nature of the infection with which we have to deal. If the infection is tuberculous we should endeavor to assist nature in the effort to keep it a local lesion. In doing this it may be necessary at times to remove infected glands and to drain abscess cavities, but at all times it is necessary to build up the general health, so that the system may offer as much resistance as possible to further infection. To accomplish this purpose good food and tonics are essential, but above all other things comes pure air and hygenic surroundings. The enlarged glands which are due to other infection require in addition to these measures, that we find the source of infection and endeavor to heal that, if we expect to stop the continued infection and rëinfection of the diseased glands. If we apply the same general principles to these diseased glands that the surgeon applies to inflamed glands in other parts of the body we shall be in a position to treat them intelligently. If the surgeon finds inflamed glands in the axilla in connection with a septic wound of the hand, he does not devote his whole attention to the inflamed glands and neglect the septic wound; further than that, if he finds inflamed glands in any other part of the body except the neck, he at once searches for the source of infection. Yet enlarged glands of the neck are always considered to be tuberculous, notwithstanding the daily illustration that we have of the involvement of these glands in practically all acute affections of the throat, and the involvement of the glands is of shorter or longer duration, as the disease of the throat is short or long in its course. It is hardly necessary to say that the removal of enlarged glands caused in this way will not cure the disease or prevent other glands from becoming involved, so long as the source of infection still exists. We should bear in mind that the tissues of a child are much more liable to infection than are those of the adult and that gland involvement occurs in many acute and chronic diseases. The adult acquires a certain immunity to infection which furnishes a more or less complete protection, unless the bodily resistance is reduced

either generally or locally, as by injury. An illustration of the lack of this immunity is furnished by the virulence of any disease which is new to a nation, or one which has not been prevalent in a country for many years, as the measles in Mexico, syphilis in the Sandwich Islands, and epidemic influenza in Europe and America. But to return to the subject of scrofula, the anaemic condition of these children which is such a prominent symptom of the disease may come from a variety of causes, among which are the vitiated tissues of the syphilitic, bad air, poor or improper food, unhygienic surroundings, and septic infection both from their surroundings and from the disease with which they are suffering.

A few cases will better illustrate some of the sources of infection which may be the cause of enlarged cervical glands, than any amount of argument.

Case 1. J. B., aged 19, was well until he had an attack of diphtheria at the age of 15; following this he had a nasal discharge (sinuses probably involved at the time of the diphtheria) and after two years the cervical glands became involved and for the next year he underwent several extensive operations for their removal, so that when he came to me his neck was seamed with the scars of these operations, and he had enlarged glands beyond the site of the former operations, which had become involved since. He was sent to me by Dr. Sopher, of Wakefield, Mass., with the request that I examine his nose and throat to see if there was any disease there which might act as a source of infection. I found a chronic ethmoiditis which was treated and cured, with the result that the remaining enlarged cervical glands underwent resolution, and no new ones have become involved for two years. There is every reason to believe that if the former treatment had been pursued, and no attention paid to the ethmoiditis, that he would have continued to have a succession of new glands involved perhaps for years.

Case 2. F. L., aged 6, suffered from a latent tonsillar abscess which caused enlarged cervical glands and one sharp attack of septic rheumatism. After the removal of the tonsils, the glands slowly underwent resolution. This case is interesting from the fact that the patient had a general septic infection in addition to the adenopathy, showing the danger of collections of pus in or around the throat.

Case 3. A. M., aged 22; his brother, a physician, brought him to me with the history of a succession of suppurating cervical glands which had extended over four years, being much worse during the winter months. In fact, during the cold weather he was hardly ever

free from a suppurating gland. The disease was supposed to be tuberculous and had been treated by the usual method pursued in these cases, with the result that one gland after another had become involved, until his neck was seamed with the scars of many battles. The removal of a part of the middle turbinal on the same side as the enlarged glands improved the nasal drainage and cured a purulent nasal discharge. After the nasal discharge ceased the diseased glands began to improve and for two years he has escaped further gland disease.

These cases might be multiplied indefinitely, but enough have been given to illustrate the point that it is necessary to treat these cases on the same principle that cases of gland disease in other parts of the body are treated, and that it is not enough to make the diagnosis of scrofula and practically do nothing for them until the glands have broken down, but that we should remember that there is a large area in the mouth, throat, and nose which is peculiarly liable to infection and to retain infection, and that the cervical glands are in the pathway of the lymphatic drainage and are almost certain to be involved sooner or later. This cervical adenitis will, of course, continue as long as the source of infection is unhealed. If I shall have directed attention to this, to me, important subject, I shall be satisfied.

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THE DIFFERENTIATION AND DIAGNOSIS OF TUBERCULOSIS AND PHTHISIS.

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For a number of years I have earnestly urged the general practitioner to study the physical aspects of tuberculosis in contradistinction to phthisis, inasmuch as therein lies the fundamental basis of all practical prophylactic measures. In this respect I am but following in the footsteps of that incomparable master, Virchow, who has ever insisted upon the sharp distinction between these two conditions.

The past decade has witnessed unprecedented progress in this particular field and perhaps no similar period in history has produced so many ardent and true scientific workers. That the studies and perquisitions of Strauss, Chaveau, Villemin, Aufrecht, Klebs, Cohnheim, Koch and others, have served to elucidate and exemplify the etiology

and pathology of phthisis cannot be gainsaid, but in the light of more recent knowledge no small part of their labors subserves an academic rather than a clinical value. Thus, not only the pathology of the so-called stages of phthisis, but the very bacillus tuberculosis itself has only a subsidiary interest at the present time.

It is to sincere, unselfish sanatória-physicians and other coworkers that clinicians are in the main indebted. Notably among them should be mentioned Czaplewsky, Maragliano, Strümpell, Petruschky, Turban, Brieger, Neufeld, Ortner and especially the brilliant Japanese, Sata. These gentlemen have given us a nosology at once simple, obvious and effectual.

Tuberculosis is a product of a gregarious civilization with all its concomitant deviations from the conditions essential to a healthy animal life. Crowding and insanitation, insufficiency of air, light, food, and water are but sequential details. Tuberculosis is primarily a local disease with constitutional manifestations. It has, to be sure, a specific infectious organism, but as Baccelli affirmed long ago, the bacillus is only the histological exponent, not the whole of the tubercle, much less the disease. Local tuberculosis, regardless of its situation in the animal economy, has the same characteristics—the *locus minoris resistentiae*—which according to Petruschky, includes primarily all organs directly in communication with the outside world—and the proliferation of fixed tissue cells resulting in a sequestration of the infective irritant. Pure local tuberculosis, whether pulmonary or articular, does not possess the time honored and respected signs of inflammation—*rubor, dolor, tumor, calor, et functio laesa.* Tuberculosis *per se* is quite afebrile and it is likewise without exudation. Tuberculosis is in no sense a pernicious process; it is a conservative one, no other disease having a greater tendency to spontaneous recovery.

Phthisis is tuberculosis plus mixed infection. Bacteriologically it is a symbiosis of two or more pathogenic organisms acting in unison. Most frequently the staphylococcus pyogenes aureus and the streptococcus pyogenes; commonly the diplococcus of Fraenkel and Pfeiffer's bacillus play an important part; less frequently Gaffky's micrococcus tetragenus and Gessard's bacillus, as well as other pathogenic and saprophytic organisms too numerous to mention.

Phthisis, then, is tuberculosis plus a pyaemia or septicaemia. The due appreciation of this condition is of paramount importance, for almost all the dreaded symptoms of phthisis are the result of this pyogenic superinfection. In other words we have but the same predomi-

nant manifestations that accompany acute suppuration, acute articular rheumatism, erysipelas, puerperal fever and the like.

To be more specific the staphylococcus pyogenes from its known liquifying action upon connective tissue is probably in the main responsible for the breaking down of tuberculous tissue. The diplococcus lanceolatus, the influenza bacillus and, peradventure, the streptococcus are almost invariably responsible for the broncho-pneumonia of phthisis, as Ortner has shown. The streptococcus pyogenes is without doubt the sole cause of the hectic fever and night sweats. It may be mentioned *pari passu* that the so-called "strepococcus curve" has repeatedly been demonstrated in the fever charts of phthisis. The bacillus pyocyaneus, as is well known, gives the characteristic greenish coloring to the sputa of consumptives.

Pulmonary tuberculosis, of itself, is manifestly without expectoration. An exudative inflammatory bronchitis of greater or less degree is essential to the production of sputa, and is always of pyogenic origin.

Pure tuberculosis consists typically of closed foci and the disintegration and degeneration of the tubercle with the consequent setting free of the tubercle bacilli is likewise only the result of mixed infection.

Hemoptysis, the erosion of a radicle of the pulmonary artery, regardless of the time of its occurence, is invariably an accompaniment of phthisis. While pulmonary tuberculosis is not characterized by expectoration, bacilli, fever or hemoptysis it must not be inferred that its diagnosis is at all difficult: Quite the contrary.

It may be stated *en passant*, that of the fifty-five hundred and odd patients sent last year to the various German sanatoria over one-third were purely tuberculous.

The following are the physical signs and symptoms of pulmonary tuberculosis:

Inspection:—Deficiency, impairment or irregularity of respiratory movement upon affected side. Evident unilateral contraction. Flattening or depression of the supra- or infraclavicular fossae. Amyotrophy of the thorax. An acceleration of respiration, more particularly in women.

Palpation:—Slight increase in vocal fremitus.

Percussion:—Defective resonance upon or above a clavicle. Want of elasticity, definite dullness, tympanitic dullness or tympany apparent upon repeated examinations.

Auscultation:—Evident changes in the respiratory murmur; it matters not whether it be diminished, weakened, rough, harsh, indefinite, sharp, rude, puerile, interrupted or exaggerated, suffice it that such modification in the vesicular respiration is constant over a circumscribed area. Most frequently the respirations are somewhat short and slightly accelerated. Inspiration, weakened or rough, and expiration somewhat prolonged. "An apical catarrh" with fine crepitation or a few localized dry ronchi or sibilant râles is pathognomonic.

Symptoms:—The constitutional disturbances are, as a rule, more pronounced than the pulmonary. There may be some dyspnoea upon exertion. There is no true cough, rather a reflex "hack," probably due to a small deposition upon the arytenoids or posterior wall of the trachea. A clearing of the throat on speaking is often noted. A transient localized pain, the dry pleuritic stitch, or a neuralgic indefinite ache in the sternal or scapular region, or a faint sense of resonance felt by the patient in talking are usually the sole subjective symptoms attributable to the lungs.

There is a slight palor, a peculiar duskiness or sallowness, a pseudo-anaemia or chlorosis readily distinguishable from the true by the presence of a leucocytosis; inequality of pupils; according to some dilatation; a general dullness, weakness, or at times a disinclination to work—symptoms frequently confounded with malaria.

A carbohydrate indigestion with eructations, acid dyspepsia, capricious appetite, anorexia, gastralgia, intestinal indigestion, coated tongue and constipation are frequently predominant symptoms A temperature of say three-tenths to one-half degree under stimulus of mental excitement or slight exertion and at menstrual period. Subjective feeling of chilliness or a slight subnormal temperature during early morning. There is a small loss of weight, determinable solely by frequent weighings, not by the opinion of patient or friends. A tendency to cyanosis of the extremities, less frequently of the lips or cheeks. The pulse is characterized by considerable instability. There is increased rapidity upon trivial exertion or mental stimulus, particularly towards evening. The pulse is often of low tension, full, soft, or compressible. Tendency to sweats, not only nocturnal, but following the slightest exertion. Changes in temperament, irritability, introspection, sweating of the palms of the hands under excitement, in women, palpitation of the heart and amenorrhoea, have all been noted.

In addition to the foregoing, age, occupation, environment, the

probability of exposure to infection, and the personal and family history should be taken into consideration.

The physical signs and symptoms of phthisis should certainly require no reiteration. It should not be forgotten, however, that hemoptysis or the occurrence of bacilli in abundance, as Brieger has well demonstrated, are evidences of cavitation. Clumps of granular bacilli indicate progressive softening, while alternation of few and many bacilli signifies the occasional opening of closed cavities with discharge of their contents. Even in phthisis one should not rely exclusively upon the presence of bacilli in the sputa, for as Neufeld has shown that while staphylococci and streptococci may be present in the sputa, the tubercle bacilli may be absent for months at a time, or if present, in so small numbers as not to be readily recognized.

The thermometer is perhaps after all the best instrument in the diagnosis of early phthisis. If the temperature be taken every two hours, after midday, a rise will usually be noted proportionate to the progress of the disease.

Again, upon examination of the chest, in phthisis, it should be remembered, as Kingston Fowler states, that in the great majority of cases, when the physical signs are sufficiently definite to allow of diagnosis, the lower lobe is already involved.

Michaelis's Diazo-reaction and Roentgen rays have proven of no utility in the diagnosis of tuberculosis or early phthisis.

The tuberculin reaction is too promiscuously present in other diseases, uncertain, unacceptable to the patient and not entirely without danger. Further, it has been repeatedly shown that the glycerin and proteids of the culture fluid are in themselves sufficient to produce a reaction without the tubercle bacilli extract. It may with truth be said of many of the advocates of tuberculin: "Quod ferre libenter id quod volunt credunt."

While *tuberculosis*, as well as a goodly number of cases of phthisis, are eminently curable, early diagnosis is of vital importance. Successful treatment must necessarily depend upon the measures taken before the lungs are extensively involved and it goes without saying that if *tuberculosis* was generally diagnosticated there would be practically no mortality.

It may be added, parenthetically, that even a "suspect" has a right to know the truth in order to protect himself; that the physician who fails to inform a poor consumptive of his condition commits an unpar-

donable sin, since he not only jeopardizes the life of his patient, but scatters the seed of the dreaded scourge broadcast.

I have elsewhere[1] gone into details upon the subject of treatment. Suffice it to say here that the perfection of sanatoria methods has been the achievement of the last ten years and embraces modern and effectual measures. A sojourn at so-called health resorts where patients are prone to do very much as they are inclined is obviously no substitute.

In the light of present knowledge, however, the location of such institutions is secondary to the ability and sincerity of the physician in charge.

LIGHT—ITS THERAPEUTIC IMPORTANCE IN TUBERCULOSIS AS FOUNDED UPON SCIENTIFIC RESEARCHES.

BY J. MOUNT BLEYER, M. D., F. R. A., M. S., LL. D.

VICE-PRESIDENT AMERICAN CONGRESS OF TUBERCULOSIS.

(Continued from Page 123.)

The calorific rays are not visible to us. If we move the bulb of a thermometer along the solar spectrum, we find that the heat begins at the indigo, and gradually rises to acquire its maximum intensity near the end of the visible spectrum, beyond the red. The most luminous part of the spectrum, the yellow, is not the hottest. On the other hand, we ascertain chemically, through the labors of Ritter and Scheele, especially by photography, that the chemical rays begin in the

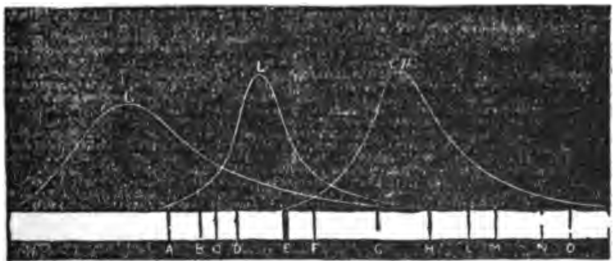

FIG. 8.—RELATIVE INTENSITIES OF HEAT, OF LIGHT, AND OF CHEMICAL ACTION IN THE RAYS WHICH REACH US FROM THE SUN

green, acquire their maximum in the violet and extend beyond it, forming also an invisible spectrum. Figure 8 represents the relation

[1] *New York Medical Record*, Oct. 13, 1900.

which exists among the three species of rays. The luminous rays extend from the red to the violet (from the left of the line *A* to the right of the line *H*), and their luminous intensity is represented by the curve *L*, of which the maximum occurs, as we see, between the rays *D* and *E*. The curve to the left, *G*, represents the calorific intensity; and the right curve, *Ch.*, corresponds to the chemical action. A sixth sense is opened to the world by the calorific rays, a seventh by the chemical rays. (Figure 9).

Fig. 9

The accompanyiny figure, (Figure 8 1-2) exhibits the chemical action affected by the various portions of the spectrum on the sensitive mixture for one particular zenith distance of the sun. The lines worked with the letters of the alphabet from *A* to *W* at the bottom of the figure, represent the fixed dark lines which exist in the solar spectrum, of which I shall speak as I go along in this artĭcle. They serve as landmarks by which to ascertain the position of any given point in the spectrum. The greatest amount of chemical action is noticed between the line in the indigo, marked *G*, and that in the violet, marked *H*. In the direction of the red end of the spectrum, the action becomes imperceptible about *D* in the orange—the maximum of visible illumination—whilst towards the other end of the spectrum the action was found to extend as far as the line marked *U*, or to a greater distance beyond the line *H* in the violet than the total length of the ordinary visible spectrum.

By way of a conclusive illustration, this same fact may be shown that a photograph can be made with these blue rays, whereas there is failure to produce the same effect with the red rays.

I want to point out another important fact right here before I go on further into my subject, viz. that the solar spectrum differs in certain

respects from that beautiful spectrum of the electric arc light with which much is now being done in photo-therapeutics, etc. It differs in this way, that the solar spectrum consists, not of a continuous band passing without a break or interruption from the red to the violet, through all the shades of color which we know as the rainbow tints, but that in the solar spectrum we find, interspersed between these, cer-

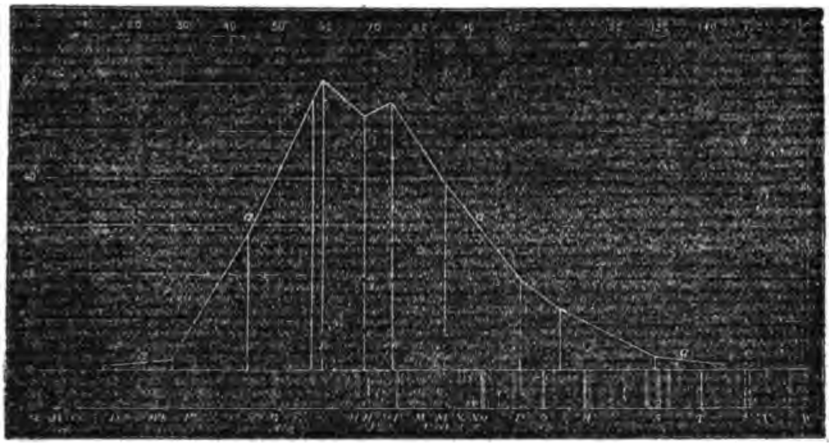

Fig. 8½

tain dark lines which we may regard as shadows in the sunlight—spaces where certain rays are absent.

What we see is nothing compared with what is constantly passing around us in nature.

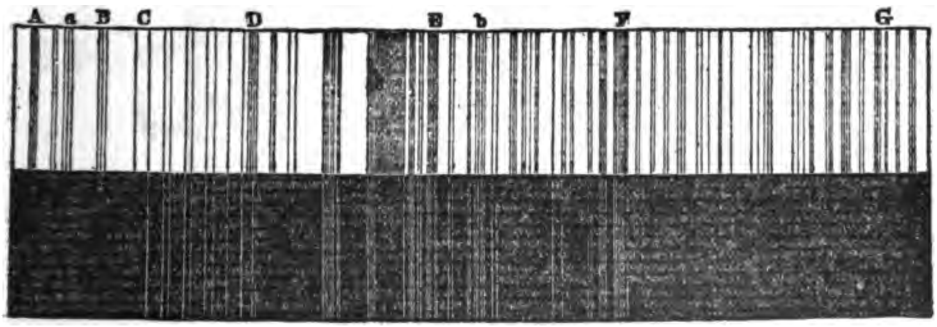

Fig. 9½

As early as 1815 Fraünhofer, a Bavarian optician, studied with care the violet spectrum and sought to discover some fixed points in it

which might be independent of the nature of the prisms, and which could be regarded as points of reference to which the zones and colors of the spectrum might be referred; when he perceived that, by giving the prism a certain special position, there suddenly appeared in the spectral image *dark lines* crossing the streamer transversely in the same colors, he designated the eight principal lines by the first letters of the alphabet. They are placed as follows:—The first at the limit of the red, the second in the middle of that color, the third near the orange, the fourth at the end of that tint, the fifth in the green, the sixth in the blue, the seventh in the indigo, the eighth at the end of the violet. These are, then, the principal black lines which we distinguish in the spectrum. As to the total number of these lines, it is really amazing. Fraünhofer counted 600 with a microscope; later Brewster carried this number to 2,000; now we count 5,000 and more. (See figure 9 1-2.)[1]

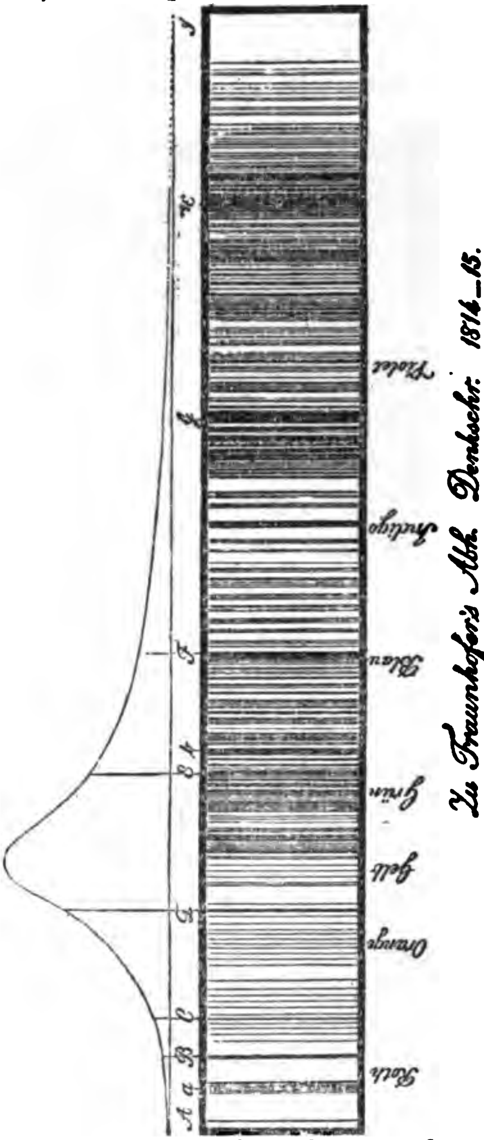

Fig. 10. The original Frauenhofer's spectrum.

These lines of the solar spectrum are constant and invariable at all times when the sepctrum studied is that of light emanating from the sun; whatever

[1]These lines are universally known by the letters given in figures, 9 and 9½.

this light may be, we find them in daylight, in that form in the clouds, in the light reflected by mountains, buildings, and all terrestrial objects. We find them even in the light of the moon and in that of the planets, because these celestial bodies shine only by the light which they receive from the sun and reflect into space.

This discovery of microscopical lines which thus cross the solar spectrum was soon made fruitful by another not less important discovery. Admitting through a prism rays issuing from a luminous terrestrial source, such as an electric arc light, as a gas jet, a lamp, a metal in fusion, etc., we notice at first that these artificial lights give rise to a spectrum as well as that of the sun, but that this spectrum differs from

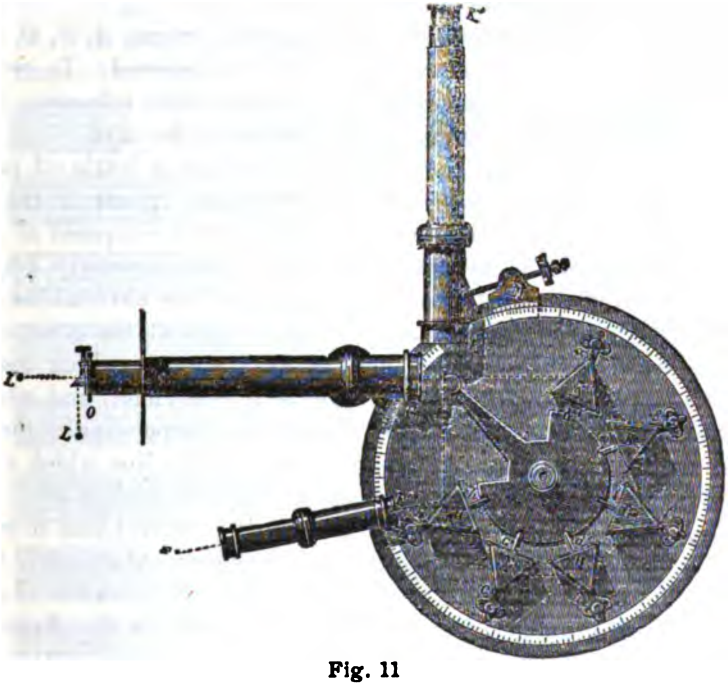

Fig. 11

the solar spectrum by the number and arrangement of the colors; we remark in the second place—and here is the important point—that the spectrum of these lights is also crossed by lines, that the distribution of these lines differs according to the nature of the light observed, and in short, that they present an *invariable order, characteristic* of each of them.

In order to fix our ideas, let me describe an experiment such as was made by Kirchhoff and Bunsen, the two physicists to whom we owe

these brilliant researches. Let us place in a gas jet, a platinum wire, at the extremity of which we put a small fragment of the substance which we wish to analyse. Before the flame is placed the spectroscope, a telescope expressly constructed for our analysis, and in which the rays from the flame pass through a prism and an analysis microscope. [The flame of our light from whatever source, is regulated and weakened so as not to give a spectrum itself.] The moment we place in the flame the prepared platinum wire a spectrum appears in the telescope and the eye placed at the microscope can analyze it at its ease. This spectrum is *that of the substance which burns.* The luminous ray leaving the point *L* (Fig. 11) is reflected from the little prism *O* at the end of the telescope, and thus appears to come from *L*. Following the axis of the telescope it is refracted successively through six prisms, *A*, *B*, *G*, *D*, *E*, *H*, and enters the telescope, *K*, by which it is observed. In order to compare or measure it, we should have in the little telescope, *F*, an image or a scale which serves to fix the position of the rays.

For example, we dip the platinum wire into a bottle of potash. The moment we place it in the gas jet, a spectrum appears in the spectroscope; this is the spectrum of potassium. It is composed of seven colors—like the solar spectrum; in addition, it is characterized by two very brilliant red rays, situated towards each of the extremities.

Similarly, if we place small crystals of soda at the point of the platinum wire, we see a singular spectrum appear, which contains neither red, nor orange, nor green, nor blue, nor violet, and which is simply characterized by a splendid yellow ray corresponding to the position of the yellow in the solar spectrum and of the line which crosses that color. We have here the spectrum of sodium, and so on.

This method of analysis is so marvelously powerful that it reveals the existence of substances in quantities infinitely small, and, where any other method would be completely abortive, the presence of *a millionth of a milligramme* of sodium discloses itself in the flame of a candle.

Thus every substance analyzed produces in the spectroscope an arrangement of lines which is peculiar to it—*it registers its true natural name in hieroglyphic characters*; it reveals itself by itself and in an incontestible form.

The black lines which are described above in the solar spectrum, *correspond precisely to certain bright lines characteristic of the spectrum of different terrestrial substances.*

On the other hand, it has been ascertained that metallic vapors endowed with the property of emitting in abundance certain colored rays absorb these same rays when they come from a luminous source situated behind these vapors and traversed by them. Thus, for example, if behind a flame in which sea salt burns we kindle a brilliant Drummond light, and if we superpose the two spectra, immediately the yellow line of sodium will disappear from the spectrum of sodium and give place to a dark line occupying precisely the same place.

It follows from this double observation that the black lines of the solar spectrum prove:—

I., The existence of a burning and gaseous atmosphere around that body.

II., The presence in that atmosphere of substances announced by the lines in question.

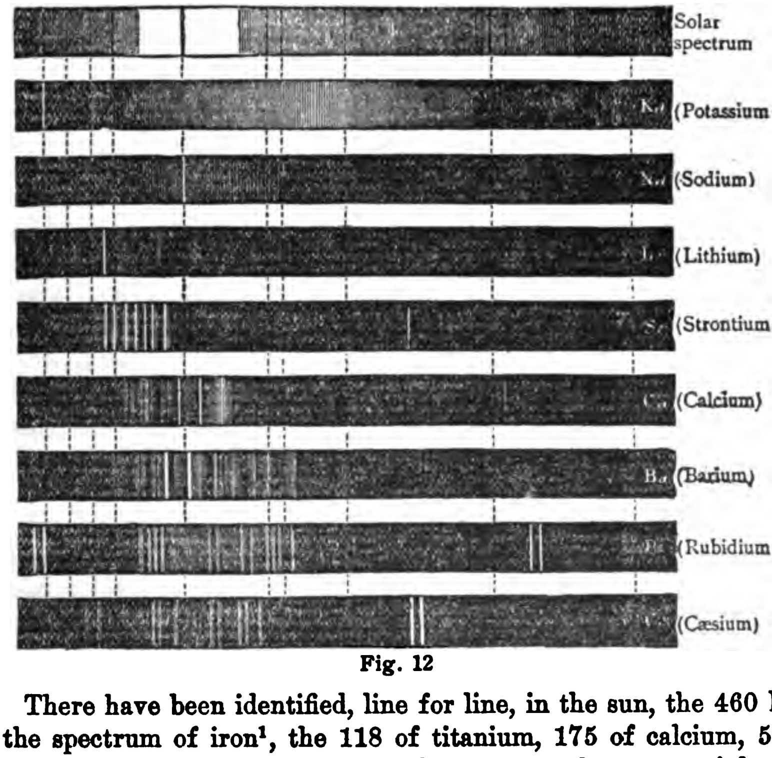

Fig. 12

There have been identified, line for line, in the sun, the 460 lines of the spectrum of iron[1], the 118 of titanium, 175 of calcium, 57 of magnesium, 33 of nickel, etc. So that we now know certainly that

[1]Prof. Roland has found over 2,000 lines of iron in the solar spectrum. J. E. G.

there are at the surface of that dazzling star, and in the gaseous state, iron, titanium, calcium, manganese, nickel, cobalt, chromium, sodium, barium, magnesium, copper, potassium; but we still cannot recognize any trace of gold, silver, antimony, arsenic or mercury. Hydrogen was discovered in 1868; oxygen must exist in this furnace, but the oxygen lines which have been found in the solar spectrum proceed from our own atmosphere (Jansen 1888). Amongst all the discoveries of modern investigation none has deservedly attracted more attention or called forth more general admiration than the result of the application of spectrum analysis to chemistry. Nor is this to be wondered at when we remember that such a power has thus been placed in the hands of the chemist and allied scientists, enabling them to detect the presence of chemical substances with a degree of delicacy and accuracy hitherto unheard of, and thus to obtain a far more intimate knowledge of the composition of terrestrial matter than they formerly enjoyed. Since its discovery the sciences in their various branches of analysis have profited much by it, in new discoveries.

HOW THE INFLUENCE OF THE SUN'S RAYS ACTS UPON THE VITAL ORGANIZATION.

The surface of our earth is rendered beautiful by the almost countless forms of vegetable life which adorn it, and on the bare surface of the wind-beaten rock the mysterious lichen finds a sufficient amount of those elements which assimilate and form its structure, to support it through all the stages of its growth; and at length, having lived its season, it perishes, and in its decay forms a soil for plants which stand a little higher in the scale of vegetable life. These again have their periods of growth, of maturity and of dissolution, and, by their disintegration, form a soil for others which pass through the same changes until at length the once naked rock is covered with a garden and the flowering shrub and the enduring tree wave in loveliness above it.

In a short time, we find the almost microscopic seed placed in a few grains of earth, springing into life, developing its branches, unfolding its leaves and producing flowers and fruit. Although it has become a stately plant, we shall not discover much diminution of the soil from which it grew, and from which it would at first appear it derived all those solid matters of which its structure is composed. Experiments have been made in the most satisfactory manner, and it has been proved that a very small amount only, of the soluble constituents of a soil are taken up by the roots of a plant. We have then to look to other sources for the origin of the woody matter, of the acid and saccharin

juices, of the gums and of the resins, yielded by the vegetable world. These are all, it will be found, formed by some mysterious modifications of a few elementary bodies. The plant in virtue of its vitality and under the excitement of the sun's rays, effects the assimilation of these elements; and these are the phenomena which it is our business to examine thoroughly if we are going to apply photo-therapeutics.

The conditions necessary to germination are moisture, a moderate temperature and the presence of oxygen gas. The experiments of Ray, Boyle, Scheele, Archord, and Humboldt all show that the presence of atmospheric air is necessary. Germination cannot take place at the freezing point of water, and at 212° all vitality is destroyed. If seeds are kept quite dry, they will not germinate, although the other conditions are fulfilled. All seeds do not germinate at the same seasons, some requiring a more elevated temperature than others which fact explains the cause of the different periods at which we find the plants springing from the soil.

It has been remarked, that Michelloti proved light to be injurious to germination, and Gugenhauz and Sennebier found that seeds germinate more rapidly even beneath the soil in the shade than in sunshine. This fact has been now established beyond all doubt.

Priestly's experiments[1] on the influence of growing plants upon the air are most instructive; and since they are not generally known, it is thought advisable to give an abstract of them in this space. "Without light," says Priestly, "it is well known that no plant can thrive and if it do grow at all in the dark, it is always white, and is, in all other respects, in a weak and sickly state. Healthy plants are probably in a state similar to sleep in the absence of *light*, and do not resume their proper functions but by the influence of light and especially the action of the rays of the sun."

Again, arguing that the green matter which forms in water grows and gives off gas, by the influence of light alone, Priestly gives the following experiment:—"Having a large trough of water, full of recent green matters giving air very copiously, so that all the surface of it was covered with froth, and jars filled with it, and inverted collected great quantities of it; and very fast. I filled a jar with it, and inverting in a basin the same; I placed it in a dark room. From that instant, no more air was yielded by it, and in a few days it had a very offensive

[1] *Experiments and Observations Relating to Various Branches of Natural Philosophy with a Continuation of the Observation on Air.* By Joseph Priestley, LL. D., F. R. S., Birmingham, 1781, Vol. ii.

smell, the green vegetable matter with which it abounded being then all dead and putrid." Dr. Priestly then instituted a series of experiments to prove that the *green matter* and not the water, produces the air. Rumford imagined that any porous body, as cotton, wool, silk, and even threads of glass would separate air from the water. Priestly's experiments were singularly conclusive on this point.

Priestly continued his experiments with the higher order of plants:—"Having by this means fully satisfied myself that the pure air I had procured was not from the water, but from the green vegetating substance assisted by light, I concluded that then aquatic plants must have the same effect; and going to a piece of stagnant water, the bottom of which was covered with such plants, I took five or six different kinds promiscuously. Then, having put them into separate jars of the water in which they were growing and inverted them in basins of the same, I placed them in the sun, and *I found that all of them without exception* were immediately covered with bubbles of air, which gradually detaching themselves from the leaves and stalks where they had originated, rose to the surface of the water; and this air, on being examined, appeared to be in all the cases very pure, though not quite so pure as that which was before procured from the green water."

It must be remembered that carbonic acid was unknown to Priestly and those who labored in the same field with him. Dr. Jugenhousz[1], for example, says:—"The air obtained from the leaves is by no means air from the water, but air continuing to be produced by a *special operation carried on in a living leaf* exposed to the daylight, and forming bubbles, because the surrounding water prevents this air from being diffused through the atmosphere. * * * * * *

"It is wonderful that this green matter seems never to be exhausted of yielding dephlogisticated air, though it has no free communication with the common atmosphere, from which the most part of other plants seem to derive their stock of air. Does this vegetable matter imbibe this air from the water, and change it into dephlogisticated air?" This does not seem to me probable. I should rather incline to believe that the wonderful power of nature, of changing one substance into another, and of promoting perpetually the transmutation of substances, which we may observe everywhere, is carried on in this green vegetable matter, in a more ample and conspicuous way.

Dr. Priestly, with his usual ingenuity, very soon determined that the plants separated some gas from the water, which they decomposed,

[1]Jugenhousz, *Experiments on Vegetables.*

and that, after a time, they ceased to give out air in water. He says:—"I put a handful of these water plants, without distinguishing their kinds, into a receiver containing eighty ounce measures of water, inverted in a basin of the same; and when they had yielded between six and seven ounce measures of air, I examined it, and found that, with two equal quantities of nitrous air, the measures of the rest were 0.8. *But the air had been diminishing about three days*, so that I believe there had been eight ounces measured in all, or one-tenth the capacity of the jar, and certainly purer than it was now found to be.

"It was evident, therefore, that *no more air would have been produced by these plants in water*, though placed in the sun. * * * * It is also a proof that the proper origin of all air produced in these circumstances is not the plant and the light, and that these are only agents to produce that effect on something else; that in all cases, the quantity of air produced bears a certain general proportion to the capacity of the vessel in which the process is made." Again, "I have found a slower and a less produce of air from rain water than from pump water; owing, I suppose, to the rain water containing less air to operate upon, and generally also in a purer state, than that which is contained in pump water." We now know that the latter contains more carbonic acid than the former.

These experiments were continued by Priestly with cabbage leaves, lettuce, the sponge, cucumber, potatoes, white lilies, and many other kinds of plants, in all of them proving the decomposition of fixed air (carbonic acid) by the living vegetable matter in the water and the influence of light. We find philosophers, both here and abroad, repeating Dr. Priestly's experiments, and gradually arriving at a correct interpretation of the observed phenomena. Cavendish, in his experiments on air, wanders round the truth, but is continually drawn away from it by the hypothesis of phlogiston. Sennebier found that plants yielded more dephlogisticated air (oxygen) in distilled water, impregnated with fixed air, than in plain distilled water. On this, Cavendish says:—"For a fixed air is a principle constituent part of vegetable substances, it is reasonable to suppose that the wood of vegetation will grow better in water containing this substance than in other water."

M. Monge, in his memoir, *Sur le Resultat de l'Inflammation du Gaz Inflammable et de l'air Dephlogistique dans des Vaisseau Clos*, also examines this question. About this time the complete explanation afforded by Lavoisier's annihilation of the phlogistic hypothesis led to

correct explanations of the facts; and we advance more steadily in our inquiries.

Robert Hunt published in the *Philosophic Magazine* for April, 1840, some very curious experiments which I, myself, followed out to my own satisfaction. It is necessary for a correct understanding of the results obtained, that all the conditions under which the experiments have been made should be distinctly stated.

Six boxes were so prepared that air was freely admitted to the plants within them, without permitting the passage of any of the solar rays, except those which passed through the colored media with which they were covered. These media permitted the permeation of the rays of light in the following order:

1. *A ruby glass, colored with oxide of gold*:—This glass permits the permeation of the ordinary red, and the extreme red rays only.

2. *A brown-red glass*:—The extreme red ray appeared shortened; the ordinary red ray and the orange ray passed freely, above which the spectrum was sharply cut off.

3. *Orange glass*:—The spectrum was shortened by the cutting off of the violet, indigo, and a considerable portion of the blue rays. The green ray was nearly absorbed in the yellow which was considerably elongated. The whole of the least refrangible portion of the spectrum permeated this glass fully.

4. *Yellow glass, somewhat opalescent*:—This glass shortened the spectrum by cutting off the extreme red ray and the whole of the most refrangible rays beyond the blue ray.

5. *Cobalt blue glass*:—The spectrum obtained under this glass was perfect from the extreme limits of the most refrangible rays down to the yellow, which was wanting. The green ray was dimished, forming merely a well defined line between the blue and the yellow rays. The orange and red rays were partially interrupted.

6. *Deep green glass*:—The spectrum is cut off below the orange and above the blue rays. Although the space on which the most luminous portion of the spectrum falls, appeared as large as when it was not subjected to the absorptive influence of the glass, there was a great deficiency of light, and on a close examination with a powerful lens, a dark line was seen to occupy the space usually marked by the green ray.

Robert Hunt's experiments show also by preparing a case containing five flat vessels filled with different colored fluids, the following:—

A—red: *Sodium of carmine in super sulphate of ammonia*:—This gives a spectrum in nearly all respects similar to that given by the ruby glass (1), all the rays above the line drawn through the center of the space occupied by the orange being cut off.

B—yellow: *A saturated solution of bichromate of potash*:—This beautifully transparent solution admits the permeation of the red and yellow rays which are extended over the space occupied by the orange ray in the unabsorbed spectrum. The green rays are scarcely evident.

C—green: *Muriate of iron and copper*:—This medium is remarkably transparent; the blue, green, yellow, and orange rays pass freely, all the others being absorbed.

D—blue: *Cupro-sulphate of ammonia*:—This fluid obliterates all the rays below the green ray, those above it permeating it freely.

E—white:—This is merely water rendered acid by nitric acid, for the purpose of securing its continued transparency. It should be noted that spaces in the boxes have been left open to the full influence of the light in order that a fair comparison might be made between those plants growing under ordinary circumstances, and the others under the dissevered rays.

It will be seen from the above that the following combinations of rays have been obtained to operate with:

1 and *A*. The calorific rays well insulated.

2. A smaller portion of these rays mixed with a small amount of those having peculiar illuminating powers.

3. The central portion of the solar spectrum well defined, and all the rays of least refrangiblity, thus combining the luminous and calorific rays.

4. The luminous rays mixed with a small portion of those having a calorific influence.

5. The most refrangible rays with a considerable portion of the least so; thus combining the two extremes of chemical action, and affording a good example of the influence of the calorific blended with the chemical spectrum.

6. Some portion of those rays having much illuminating power, with those in which the chemical influence is the weakest under ordinary circumstances.

B. The luminous rays in a tolerably unmixed state.

C. The luminous rays combined with the least actively chemical ones, as in *6*, but in this case the luminous rays exert their whole influence.

D. The most refrangible or chemical rays well insulated.

E. White light.

From these arrangements it will be evident that, although we do not secure the complete isolation of the rays, as we should do with a prism, we obtain the great preponderance of one influence over others, which suffices to insure, to a certain extent, the decided action of that one.

I am well aware that we only arrive at approximation to the truth by the system adopted, but am unacquainted with any method by which these experiments could be continued for any time otherwise than with absorptive media.

When we look on a spectrum which has been subjected to the influence of some absorptive medium we must not conclude, from the colored rays which we see, that we have cut off all other influences than those which are supposed to belong to those particular colors.

Although a blue glass or fluid may appear to absorb all the rays except the most refrangible ones, which have usually been considered as the least calorific of the solar rays; yet it is certain that some principle has permeated the glass or fluid, which has a very decided thermic influence, and so with regard to media of other colors.

The relative temperatures indicated by good thermometers placed behind the glasses and fluid cells, which were used, will place this in a clear light. The following results present a fair average series, and distinctly mark the relative degrees in which these media are permeable by the heating rays:—

GLASSES.

Color	*Luminous rays not absorbed.*	*Temperature.*	
1. *Ruby*.	Ordinary red and the extreme red	87	Degrees
2. *Red*.	Ordinary red and orange portion of extreme red	83	"
3. *Orange*.	Little blue, green, yellow, orange, red and extreme red	104	"
4. *Yellow*.	Red, orange, green and blue	88	"
5. *Blue*.	Violet, indigo, blue, little green and some red	84	"
6. *Green*.	Orange, yellow, green and blue	74	"

FLUIDS.

A—*red*.	Ordinary and extreme red	78	Degrees
B—*yellow*.	Ordinary red and yellow	80	"
C—*green*.	Blue, green, yellow, orange	69	"
D—*blue*.	Green, blue, indigo, violet and trace of red	73	"
E—*white*.	All the rays	89	"

In these examinations the highest temperature was not obtained behind the red media, but behind those which have a yellow or orange tint.

Such were the arrangements adopted; these were sometimes slightly varied, but not to an important extent.

THE FACTS THAT ARE KNOWN FROM RESEARCHES ON THE INFLUENCE OF THE SOLAR RAYS ON THE GROWTH OF PLANTS.

Although there are still many important points which remain open for investigation and others which although examined, require, from the complexity of their phenomena, still more minute research. Nevertheless many important facts connected with the process of germination, and vegetable growth as affected by solar light, are known which warrant further research into that domain and into that of animal life.

There has arisen a habit of referring all the effects observed in the process of vegetation, etc., to the agency of light, whereas, it appears that some agencies which are not luminous materially influence the phenomena of vegetable vitality.

Without entering into any discussion in this place on the probable existence or otherwise of a principle distinct from light and heat in the sun's rays, to which we refer the curious chemical changes produced by solar influence, it will be sufficient to admit the existence of three distinct classes of phenomena which cannot, I think, be disputed.

These are luminous influence—*light*; calorific power—*heat*; and chemical excitation—*actinism.*

The problem which these researches were directed to solve was the proportion and kind of influence exerted by light, heat, and actinism —as the principle supposed to be active in producing the chemical phenomena of the solar rays has been called—in the various stages of vegetable growth.

The means we have of separating these phenomena from each other are not very perfect; indeed, in the present state of our knowledge, it is impossible to have evidence of the operations of either light, heat or actinism, absolutely separate from each other. If we use the prismatic spectrum, we have over every portion of it a mixture of effects. Even in the mean yellow, or most luminous rays, we have a considerable amount of thermic action, and, under some circumstances, evidence of chemical power. In the violet rays which have been particularly distinguished as chemical rays, we have light and heat, and in the calorific rays we have decided proof of both luminous and actinic power. Experiments show with the prismatic spectrum, that we have, in fact, no certainty, that the results due to a particular ray—that ray being regarded as the representative of a particular phenomenon—are

not the combined effect of the three forces. The same objections apply to absorbent media, but the amount of each influence is readily determined; and we are therefore enabled to refer any particular result to a tolerably well defind agency.

Before the British Association these facts were made very clear by a large number of exceedingly interesting crucial experiments, and all were embodied in a report thereon. They showed that under the action of those radiations which have permeated variously colored media, such as tinted glass and colored, transparent fluids, it was not sufficient to state that a yellow, red, or blue glass or fluid was employed, as it by no means followed that these media are permeated only by the rays corresponding in color, or by the influences due to a given order of refrangibility.

The difficulties which oppose themselves to experiments made with colored media have been strongly felt by other observers.

Dr. Dauberry says in his memoir, "On the Action of Light Upon Plants, etc.:"[1]—"The difficulty, however, of comparing the relative intensity of the light transmitted by the variously colored media, which were employed in my experiments, induces me to content myself with showing that the effect of light upon plants corresponds with its illuminating rather than with its chemical or calorific influence; and to waive the more difficult inquiry, whether its operation upon the vegetable kingdom exactly keeps pace with the increase of its own intensity."

In 1842 and 1844 Robert Hunt again reported before the British Association the following which are the facts:—He stated the kind of examination to which he then subjected each colored screen—"Many effects which have from time to time presented themselves, have convinced me of the necessity of a still more close examination of the order in which radiant principles permeate the media employed. I have, therefore, in every case examined with all care the illuminating, calorific, and chemical effects of the solar rays which have passed the media employed. The amount of light has been determined by measuring off, in parts of an inch, the prismatic rays which pass the screen. This is preferable to any system of measuring which depends upon the power of the eye to appreciate either light or shadow. Having formed a well defined spectrum on a white tablet, and carefully worked off the center of the yellow ray as being the point of maximum light, and the limits of each of the other rays, the transparent colored medium was interposed and the amount of absorption observed. These examinations,

[1] *Philosophical Transactions*, Vol. CXXVII., 1836.

many times repeated, were made with reference to the luminous rays only; and, in the description of my experiments, I shall, considering the unabsorbed ray as being represented by 100, express the amount of light actually effective by such a number as may give the sum of the rays measured off after permeation."

The calorific influences which escape absorption, and which have been determined by the expansion of the mercury in a thermometer with a blackened bulb, placed behind the colored glass or fluid, and by the evaporation of ether from a sheet of blackened paper, as recommended by Sir John Herschel, will be expressed numerically in the same way as light, without reference to the color of any ray. I am far from considering the thermic influences of the solar rays, as quite independent of the color of the ray with which they may be associated; but in these experiments on plants, it appears to me, we can only deal satisfactorily with the total amount of radiant heat which is active under the conditions of the experiments, the terrestrial heat being in all comparative experiments the same."

It has, indeed, been shown by Dr. James Stark[1] by direct experiments, and indirectly by other observers, that color exerts a very powerful influence in the conduction, radiation and permeation of heat. Following up some of these experiments both from a scientific and therapeutic point of view myself, I found that tuberculous patients derive the best results by either wearing white garments over the entire body or in a perfectly nude state. This mode of treatment I have followed since 1890 and never since then has this method depreciated in my judgment, even one per cent.

The determination of the chemical principle of the solar rays, or actinism, permeating the media employed, required more exact attention than the other phenomena.

The experience of many years enables me now to state that we are not acquainted with any transparent medium which is absolutely opaque to actinism. Although nitrate of silver, or indeed any of the salts of silver remain unchanged behind yellow glasses and fluids, yet, chlorophyl is deoxidized and turned yellow by the chemical principle which is enabled to permeate them. Upon all those bodies on which light exerts a direct and determinate influence, as upon the organized compounds, we find that the changes due to actinic power are but slightly interferred with, whereas upon all those inorganic bodies which undergo a change when exposed to the solar chemical radiations—that

[1]*Philosophical Transactions*, Vol. CXXIV, 1833.

change being entirely due to actinism—light acts as a powerful interfering agent. The conditions under which these antagonistic forces—light and actinism—operate upon each other are unknown to us, but it is certain that every combination of an inorganic salt with an organic body presents a different scale of action.

Nitrate of silver uncombined with organic matter undergoes no change by the influence of any portion of the solar spectrum, or of white light; spread it on a paper, or combine it with gum or gelatin and all that portion of the spectrum above the green ray blackens it; and if we combine this salt with unstable organic compounds, the blackening is found to take place, eventually, under every spectral ray. The other salts of silver and metallic salts in general are affected in precisely the same manner. From a knowledge of these facts it became evident that some means must be devised for ascertaining, as correctly as possible, the entire quantity of this chemical principle, passing every particular medium, without which knowledge any result would be almost valueless. In every instance, therfore, the influence of the modified radiations was determined: firstly, upon the most sensitive silver salts; secondly, upon organic bodies, as the colored juices of leaves and flowers, and on chlorophyl; and thirdly, upon combinations of the organic and inorganic materials. In this way I have reached a degree of correctness which has not been hitherto attained, and the results of the experiments have consequently a higher value.

It has been repeatedly stated that seeds would not germinate under the influence of light, deprived of that principle on which chemical change depends. There is some difference of opinion raised on that point by several, and those numerous experiments made by Gardner with the prismatic rays themselves have unfortunately furnished us with no knowledge of a degree of stability which he was enabled to ensure for the prismatic rays with his heliostat. Dr. Gardner's reseaches corroborating those of Dr. Draper are without doubt valuable; but for the reason which already is stated in this article, I must contend that we do not secure a separate action of light and actinism by the prism so effectually as by the use of absorbent media. It has been shown by Mr. Hunt, after many years of practical and convincing observation, "that light is injurious to germination and that Dr. Gardner's experiments must have been deceptive." Mr. R. Harkness[1] in reply to Dr. Gardner on this point says:—"We know, both from observations of Gugenhauz and Sennebier, as well as from daily experience,

[1]*Phil. Magazine*, Vol. XXV, N. S., p. 340, 1844.

that the absence of solar light is one of the conditions almost necessary for the germination of seed, and consequently we should not expect that ray in which the maximum of light is found to facilitate germinaton, but on the contrary, as in Mr. Hunt's experiments to retard it." There are other objections made from a physio-chemical point of view. Many experiments toward clearing up this point were made by Mr. Hunt, which gave satisfactory evidence that light deprived of the principle or power of chemical action arrests the development of the plant by preventing the vitality of the germ from manifesting itself.

Although the visible sign of germination is the process of chemical combination of the carbon with oxygen and hydrogen, yet the power influencing this change is of an occult character, though evidently dependent on some external excitation which Mr. Hunt has proved not to be light, or the principle producing the phenomena of color.

The question of importance which Mr. Hunt also raised and proved true was to ascertain if the chemical principle of the solar rays produced any acceleration of the germinative process. He found that the periods of germination differed in each variety of seeds, under the conditions to which they were exposed, yet in every instance the seeds influenced by actinic radiations germinated in one-half the time which those seeds placed in the dark required.

Several arrangements were made for the purpose of ascertaining if the influence of the chemical rays was confined to the surface of the soil, or if it extended below it. The result was, that Mr. Hunt obtained the most satisfactory evidence that, under the influence of the rays which passed the blue glasses, germination was set up at a depth below the surface, at which under the ordinary conditions it did not take place. These facts go to establish, and in addition they prove, that there exists an influence which is always associated with light and which has the property of accelerating the process by which the embryo swells, bursts through its integuments, sends its radicle into the soil, and shoots its cotyledons upwards towards the light.

The condition of the seed in this process is tolerably well understood. The seed, a highly carbonized body, is placed in a position by which its starch ($C_{12} H_{10} O_{10}$) is changed into gum ($C_{12} H_{11} O_{11}$) and sugar ($C_{12} H_{14} O_{14}$). Here we have a large absorption of oxygen; and experiment has shown that carbonic acid (CO_2) is formed. The whole process is the same in character, as the blackening of a solution of nitrate of silver, holding organic matter, in the sunshine. Without the organic body the silver salt remains unchanged; with it a com-

bination with the oxidized carbon is effected at the same time as the organic particles take the oxygen from the oxide of silver in solution. All this is known to be entirely dependent on actinic power and independent of luminous action, and the whole process of conversion in the seed is of a like character.

Here is another singular fact. If the young plant continues to grow under the influence of the rays which have permeated the blue media employed in the experiment, it will for some time grow with great rapidity, producing, however, succulent stalks which soon perish. Even in the earliest stages of the growth it will be found, that the plants grown in the full sunshine, or under the influences of yellow or red media, representing the luminous and calorific principles, give a larger quantity of woody fiber and less water than those grown under actinic influence.

Another true explanation is further proved by the fact that in the practice of planting shoots the use of blue media is highly advantageous. It appears to increase the tendency to the development of roots, and it is satisfactory to learn that some gardeners have, without any knowledge of the cause, employed cobalt-blue glasses to aid in the "striking of cuttings." Dr. Lindley[1], referring to the experiments of Dr. Dauberry, seems disposed to regard the effects described as due to the absence of light merely; it is however, evident that the chemical principle of the solar beam materially assists in the development of new roots from cuttings. The formation of woody fiber depending on the secretion of carbon from the carbonic acid absorbed by the leaves, and decomposed, by some functional power of the plant, under the influence of external excitement, it has ever been considered important to determine if this was due to the luminous rays or to any others.

The experiments of Sennebier[2] went to prove that plants decomposed the carbonic acid they absorbed by the leaves much more readily under the influence of the violet rays than any others. This power of decomposing carbonic acid under the influence of the solar rays is a function due to some vital principle; which proves the position correctly taken by Matteucci[3]:—Different plants not only decompose carbonic acid at different rates, but they exhibit greater or less sensibility to luminous influence.

The conclusions from numerous experiments induced several scientists to draw these facts:

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[1] *Theory of Horticulture*, p. 215.

[2] *Mem. de Phys. Chim.* Tom. II, p. 55.

[3] *Supplement a la Bibliotheque Universelle de Geneve.*

That the luminous principle of the sun's rays is essential to enable the plants to effect the decomposition of the carbonic acid of the atmosphere and form their woody structure.

That some plants require more light than others to effect this decomposition.

It may be inferred from all the results obtained by actual experiments that the decomposition of the carbonic acid by plants under the agency of light is not a simple chemical operation, but the result of an exertion of the vital principle of the growing plant, which requires the external stimulus of light to call it into action.

I have made numerous experiments and have every reason to believe that it will be found that there is as great a difference between the effects produced on growing plants by the prismatic rays, as we know to be the case in photographic preparations;—the maximum effects altering, perhaps, for every variety of plant. It was these known facts that led me and others to subject the various living organisms in culture fluids, plates, etc., to the prismatic rays, so that some definite conclusions could be arrived at; as to their power, individual and combined over their growth, development, sterility, bacteriocidal value, etc. To this I shall again refer in this work.

A number of comparative experiments have been made with the unabsorbed prismatic rays, with a view to the settlement of several points at issue. The method pursued has been to place leaves in small tubes filled with water impregnated with carbonic acid, and to place these tubes across the rays formed by a very excellent flint-glass prism. The results have varied with every experiment.

If we place a small sprig covered with leaves in the tube we get the largest quantity of gas in one ray; if we remove the leaves from the branch, we shall then get the most gas under another ray. No two plants as far as I am aware, gave the same quantity of oxygen in the same time, under the influence of the same ray, and the age of the plant most materially alters all the effects, the same plant at one age giving evidence of being excited most readily by the blue rays, and at another by the yellow or the red rays. Moreover, I am satisfied that by removing a member, whether a branch or a leaf, from the plant, we give a shock to the living system which prevents our obtaining any results which shall actually represent the true conditions of the growing plant. On this point the experiments of Matteucci[1] are most satisfactory.

[1]Cimento, Juillett et Aout, 1846.

In all experiments on the human being and on plants, it must be borne in mind that we are dealing with an organized body endowed with peculiar vital functions. As these are ever liable to derangement from numerous causes which are almost beyond the reach of our examination, it is only by a great numebr of crucial experiments that we can arrive at an approximation to the truth. It is, however, evident, from careful comparison of the results obtained, that *light* as distinguished from *heat* and *actinism*, is the principle on which the secretion of carbon and the evolution of oxygen by plants depends.

De Candalle succeeded in producing the green color of the leaves by the strong light of lamps, which we know give out a much larger quantity of yellow rays than any others; consequently it was inferred that light was necessary to the production of chlorophyl. Dr. Dauberry, however, obtained no result from the action of incandescent lime which emits a much purer white light, producing also chemical effects in a marked manner.

Dr. Lindley[1] refers the formation of the coloring matter of leaves to "the effect of decomposed carbonic acid and exhaling oxygen" by the agency of light, the intensity of color being in general "in proportion to the decomposing cause, that is to say, to light."

Some very interesting experiments are found recorded by numerous men who have tried to show that to the different rays in the spectrum is ascribed the office of different action. One important experiment was followed up by means of a heliostat being placed outside of a window from which was directed a pencil of light upon a flint-glass, equilateral prism; the prismatic spectrum was received in the dark chamber of an ordinary photographic camera, the place of the lense being occupied by a diaphragm which admitted the passage of the spectral image only. It was found, however, that the spectral image did not remain under the best conditions for more than three hours at a time. However, over every part of the spectrum giving light, the color recognizable by the unaided eye, the leaves of seedlings of the common cress, mustard, mignonette, and peas, which were in an etiolated state, became, after a longer or shorter time, green. In these as in other experiments, it was found that every variety of plant appeared to be influenced by different rays. It must be, however, observed that the influence was always most decided between the limits of the mean orange and the mean blue rays, and that it took much longer to green plants in the red than it did in the blue ray.

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[1] *Theory of Horticulture*, p. 86.

Such are the results found recorded wherever I have hunted for evidence to prove my position in the spectrum work. Though some objections have been urged against the use of colored media in experiments, I am, after years of experience in the use of media, convinced that there is no other way of obtaining correct results without them. All the colors of the spectrum are merely modifications of the intensity of luminous power and it has been shown that light, heat and chemical action or actinism, are common to every ray, the difference being only proportional. Therefore, because an effect is produced in the yellow ray, we have no evidence that light alone is the agent; it may be due to the combined influence of light and the other principles. We have the means of analyzing with great correctness the permeability of colored media, and we can with considerable facility, by increasing the color or thickness of a fluid medium, produce almost any order of radiation, which may be maintained for days or months, in a constant character. For instance, a yellow medium does not imply the use of a yellow light or a red one the passage of red rays only, but a well regulated, yellow medium will give the most light with the least quantity of actinism, and a blue one, the largest amount of actinism with the least quantity of light. It will now be understood that I place more confidence in the results obtained under colored media than any which can be obtained with the prismatic spectrum upon growing plants and other experiments in physiological, bacteriological and photo-therapeutics, etc.

It has been shown that chlorophyl is formed under the combined influence of light and actinism. We can easily repeat that experiment with colored media which cut off the heat rays, but which admit the luminous and actinic rays. It will be found that plants grow of a lively green and the extracted green of their leaves is preserved without change much longer than under any other conditions. To produce chlorophyl a recombination of the elements which light assists the plant to separate from the water and the air is necessary; and there is no doubt that it will be proven that chlorophyl results from the combined influences of light and actinism in exciting one of those mysterious functions of plants which excite the admiration, but elude the curiosity of the physiologist.

Mr. Hunt says, "that he rarely succeeded in getting plants to flower under the influence of any of the media which cut off those rays usually termed the calorific rays." There is something in that, where also photo-therapeutics are applied. "For instance, under intense yellow, deep blue, or very dark green glasses, however carefully the plants

may have been attended to, there was seldom any evidence of the exertion of their reproductive functions." This evidently arises from the necessity of some check upon the chemical actions which depend on light and actinism, and which exhaust the elements in the formation of wood and vegetable juices which are necessary for the production of those principles which go to the preservation of the species.

It should be again explained, that by *light*, I mean to express all those rays of the spectrum which are visible to a perfectly formed human eye; by *actinic principle*, the principle to which the phenomenon of chemical change under solar influence or the electric arc belongs; and by *calorific radiations*, not merely those effects which are traceable by any thermometric instruments, but also those which we can detect by the protection change, produced by a class of rays existing near the point of maximum heat in the spectrum.

[TO BE CONTINUED.]

A STUDY OF THE DIAGNOSIS OF INCIPIENT PULMONARY TUBERCULOSIS BASED UPON THE PATHOLOGY OF THE DISEASE.

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The great interest which has been awakened in the subject of tuberculosis in recent years has caused this dread disease to assume a brighter aspect. It is not the hopeless disease that it was formerly considered to be; for with the awakened interest, has come a better understanding of its nature. We have learned, as Professor Brouardel says, that it is not only curable, but the most curable of all chronic diseases. The curability of the disease depends, however, upon the attending circumstances; such as, the earliness of diagnosis, the resisting power of the patient, and the peculiar form that it may assume. We can not control the form of the disease; but we can increase the resisting power of the patient and, above all, improve our ability as diagnosticians so that we may detect the disease when it first makes its appearance.

The attitude of the medical profession towards tuberculosis has depended very much upon and kept pace with its ability to make an early diagnosis. Before the discovery of the bacillus tuberculosis the disease was rarely recognized, except by expert diagnosticians until the lung was badly involved and the clinical symptoms had become pronounced; hence, as a disease, it was of little interest to the profession; but, thanks to Koch's great discovery, physical diagnosis has improved and cases with this dread malady are diagnosed much earlier than for-

merly. Since the discovery of the specific cause of tuberculosis, whenever suspicion has existed the sputum, if present, has been examined. In this way practitioners have learned that the earliest symptoms are very slight. Not content here, we are now even daring to go back of the microscope and diagnose tuberculosis before the open stage has been reached; and the time is not far distant when we will no longer look to that instrument to confirm our diagnosis of incipient pulmonary tuberculosis.

The sanatorium movement in Germany is already causing our professional brethren across the water to take an advanced position on the subject of early diagnosis. In these institutions the great advantage of detecting the disease in the initial stage is so well appreciated that the profession is taking a stand with Brandenburg[1] who says:—"The time is passed when it is customary to seek for tubercle bacilli in the sputum as evidence of beginning phthisis." And again:—"It is safe to say that not over one-half the patients who have gone to Grabowsee (a sanatorium for which he is one of the examining physicians) had bacillus-bearing sputum when they entered." In a former paper[2] when refering to early diagnosis, I quoted the experience of Weicker of Goerbersdorf, who says that of the past fifteen hundred cases at his sanatorium diagnosed as tuberculous by the physical signs, in about one-third of the cases, no tubercle bacilli had yet apeared in the sputum.

The chief reason that Germany is in advance of other countries in her skill in early diagnosis is because of the great public interest which has been created there. The people have been educated to the fact that the early signs of the disease are very slight; and, also that there is great advantage in having it recognized in its incipiency; so, they often present themselves for examination when the disease has made its first appearance. Men who are thorough diagnosticians have been appointed to examine applicants for the people's sanatoria; and, through their constant practice in examining early cases, have been able to make physical diagnoses, for the most part, independent of the microscope.

While the physicians of Germany are diagnosing their cases before the advent of bacilli in the sputum and are giving their patients the benefit of this most favorable time for treatment, let me quote from Trudeau[3], one of our foremost workers in this field, to show how remiss we,

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[1]Brandenburg: *Berliner Klin. Wochenschrift*, 1900, No. 16.

[2]Pottenger: "Steps in the Prevention of Tuberculosis." *Journal of Tuberculosis*, Vol. III, p. 228.

[3]Trudeau: *Medical News*, June 29, 1901, p. 1014.

as a profession, are in this country. He says:—"A man who has acted as examiner for the Adirondack Cottage Sanitarium for years, in a large city, says, that not a really incipient case of tuberculosis has ever been referred to him for examination." And again he says:—"The histories of 70 per cent. of the applicants for admission to the Adirondack Cottage Sanitarium show disease of from one to three years' standing." To show that this is no exception, I will quote Bowditch's[1] experience at Rutland. He says:—"The average duration of symptoms of disease prior to entrance in all cases was 15.7 months." This is not an unusual experience for any man who is dealing with tuberculous patients, but it is a sad state of affairs and one that should be remedied. Perhaps the blame for this condition of affairs should be laid to the public and the medical profession conjointly; to the public in that those suffering from incipient tuberculosis rarely present themselves for examination; and to the medical profession, in that it has not educated the people when to suspect the beginnings of this disease, and, furthermore, has not treated the early symptoms, when presenting, with sufficient respect. Wherever the blame rests such a state of affairs is a strong plea for more careful study and more adequate teachings upon this important point. The public must be informed. Tuberculosis is the people's disease and it can be stamped out only by their intelligent aid; so, there should be an organized united effort upon the part of both the medical fraternity and the laity to carry an adequate knowledge of the disease to all the people of the land. They should be taught when to suspect it in its incipient stage, and that this is the favorable time for treatment. Physicians should also do their part by thoroughly mastering the signs and symptoms which are essential to an early diagnosis of the disease. Then such experiences as are detailed by Trudeau and Bowditch could not exist. I do not believe I am wide of the mark when I say that the time is near at hand when an early diagnosis in tuberculosis will be only a diagnosis before tubercle bacilli have appeared in the sputum.

One cannot expect to be able to detect the early changes in pulmonary tuberculosis unless he understands what these changes are and what produces them. To this end it would be well for us to freshen our memories on the pathology of the disease; for, while we often hear that pathology is dry, yet it is the pith and marrow of diagnosis and the only guide for a rational therapy.

[1]Bowditch: *Fifth Annual Report of the Trustees of the Mass. State Sanatorium at Rutland.*

When bacilli have found lodgment in the pulmonary tissues certain phenomena take place. These are caused by the presence of the bacilli, acting as foreign bodies, by the toxins produced, and by the multiplication of the bacilli themselves, as well as by the increase of the local cellular elements. The effect produced is that of an irritation of the part affected with an exudation of leucocytes and serum around the bacilli and, also a proliferation of the local fixed tissue cells. These together form the tubercle. Experiments have shown that it takes from ten days to three weeks for the tubercle to form.

The tubercle formed, the bacilli therein may perish and resolution take place; the cells may organize into fibroid tissue; or necrosis may follow. Blood vessels do not form in this new tissue; on the other hand, those that do exist are apt to be obliterated. This necrosis is due to several causes, of which, perhaps, the most potent is the destructive action of the substances produced by the germs themselves; but it is also thought to be partly due to the absence of bloodvessels and the pressure due to the increased number of cells. Whatever be the cause, this is the most common fate of tubercle; and it may take place soon after the invasion or not until months later.

Not until necrosis takes place can we find bacilli in the sputum, although tuberculosis be present; so, if it is practicable to diagnose the disease before this takes place, much valuable time to the patient may be saved; and, if proper treatment be instituted, the danger of reaching the open stage of the disease will be avoided.

The orignal invasion of the bacilli may be very extensive or very slight. Gradually from this primary focus the surounding tissue becomes infected; but, no matter how slight or how extensive the process may be the individual tubercles are subjected to the changes above mentioned and the course of the disease and its outcome depend on whether resolution, proliferation or degeneration takes place.

Before entering upon the discussion of the data furnished us by the various methods of examination, it may be well to discuss the subject from a general standpoint.

In examining a patient for the initial lesion of tuberculosis the chest must be bare. The day of examining through shirts, coats, and corsets is past; for, when the examiner can detect the trouble through the clothing, the diagnosis is of little value to the patient. The first changes are so slight that they cannot be detected save by most careful methods; so a bare chest is a necessity.

The chest must be examined systematically. It is not sufficient to listen in one or two places over the anterior portion of the chest, but every inch of lung tissue should be covered. After examining the apex very carefully, the anterior portion of the chest should be examined by beginning at the sternum and the posterior portion by beginning at the vertebral column. Then, passing out toward the axilla, the examiner should listen in three or four places in each intercostal space, noting whether or not the respiratory murmur is as full and loud as normal; the relative time occupied by inspiration and expiration; the character of the note, whether clear, rough, interrupted or harsh; and whether moisture exists. Sometimes this latter shows itself only as a sensation of stickiness, sometimes as a click at the end of inspiration, at other times as fine crepitant râles.

The first instructions to be given a patient, presenting himself for examination are to be perfectly natural and to breathe just as though the examiner were not present and not to take a deep breath until he is told to do so. The method which we often see of the examiner seating himself before the patient and telling him to take a deep breath can not be condemned too strongly; for, it often changes the whole picture as revealed through the stethoscope. If moisture be present in small quantities, it will often times be cleared up by this deep inspiration so that it can not be detected again until a considerable time has elapsed. The first examination should be made during quiet respiration. If there is a suspicion of moisture anywhere, but no distinct râles, let the patient cough and follow it by a deep inspiration while the stethoscope is placed over the suspicious spot. If moisture be present the ear will likely detect it.

The findings of the two sides must be compared, remembering the natural differences of the two apices—the vocal fremitus more intense, percussion note duller in quality, higher in pitch, less intense, the respiratory note exaggerated with expiration prolonged, raised in pitch and somewhat tubular on the right side—due to certain anatomical differences in the lungs and their bronchi. The ability to recognize the slight differences between the two apices is a good preparation for the detection of incipient tuberculosis.

It must be remembered that an apical catarrh, if confined to one side is very suggestive of tuberculosis.

The examiner should bear in mind that he is looking for the changes caused by the presence of a few small tubercles from the size of a millet seed to that of a pea. These may be scattered through the

tissue or aggregated; but, however distributed, the changes produced by them will necessarily be slight and detected only by careful, skillful and oftentimes repeated search. He must remember, however, that if he has detected them he has saved a life, provided the proper treatment is at once instituted.

There are certain sources of error besides the natural differences of the apices that are likely to confuse the examiner unless he be on his guard. Some times there is a slipping of a tendon beneath the scapula with each respiratory movement of the chest, which produces a sound not unlike a crepitation produced in the chest itself. That this is due to the tendon, can be proven by raising and lowering the shoulder while the patient ceases breathing. Leyden[1] calls attention to a sound simulating crepitation that is produced by the stethoscope rubbing on the clavicle.

We hear quite a little about the "pretubercular stage." I believe this to be a misnomer. Patients are either tuberculous or not, and as we become better able to detect the incipient stage of the disease, we find that the period shortly after the invasion of the bacillus, seems to correspond with that designated as pretuberculous; and, when by improved methods of examination, we are able to designate the prebacillary stage alone as incipient tuberculosis, the name *pretubercular* will fade from use.

With this brief review of pathology and these general remarks upon the method of examination, let us now proceed to interpret the pathological condition attendant upon incipient pulmonary tuberculosis by the physical signs and clinical symptoms present.

PALPATION. In the very earliest stage of tuberculosis, we would not expect much help from this measure in detecting increased fremitus unless the invasion were extensive and the individual tubercles were very close together, in which case we would have an increase in the vocal fremitus; but, with scattered tubercles, this sign would be negative or very slight. However, by placing the hands over the affected part we can sometimes detect a lessening of the respiratory excursion. This defective expansion is of great importance, especially if accompanied by other physical or clinical symptoms. Anders[2] says of it:—

[1]Leyden: *Ueber die Fruehdiagnose der Lungentuberculose. Die Lungentuberculose in ihren Anfangstadien*, Redigirt von Dr. Schaper, Berlin, 1900, S. 79.

[2]Anders: "The Diagnosis and Treatment of the Prebacillary Stage of Pulmonary Tuberculosis," *Journal of the American Med. Assn.*, Jan. 12, 1901, p. 74.

"I regard defective expansion at or a little below one apex as profoundly significant, particularly if observed in the infraclavicular space, and in some of my cases "lagging" was the first and for a considerable period of time the only recognizable physical sign."

PERCUSSION. The same can be said of percussion as of palpation. In the majority of cases, this measure gives us absolutely negative results; but, at times, through it, we obtain very valuable information. Unless the crop of tubercles were quite dense there would be no marked dullness of the percussion note in the beginning of tuberculosis although the resonance might be somewhat impaired and the pitch of the note be somewhat higher than normal. In fact the man who aspires to be able to diagnose incipient tuberculosis, must learn to look only for little things. Some times we are able to elicit a note which approaches the tympanitic in quality. This is due to an impaired elasticity of the underlying pulmonary tissue and caused by the deposit of tubercles, here and there changing the normal consistency of the lung.

AUSCULTATION. Auscultation requires the most care and the greatest skill of all procedures in pulmonary diagnosis. Corresponding with its difficulty and proportionate with the skill used is the value of the information which it gives. In incipient pulmonary tuberculosis the slight changes are detected more readily by auscultation than by any other procedure. When we recall the pathology of this early stage, the slightness of the auscultatory signs is self-evident. A few scattered tubercles produce little more than a slight local hyperaemia with an encroachment on the air-conducting tubes; and, the signs heard upon auscultation depend upon the degree of hyperaemia and encroachment present, and will be slight or more manifest according as the lung tissue is invaded by few or many tubercles and as they are scattered or massed together. This hyperaemia interfers with the normal elasticity of the lung, causes a narrowing of the lumen of the air passages, prevents the normal aeration of the part and thus causes the so-called "lagging." It also accounts for the diminished respiratory murmur which is one of the earliest signs of the incipient stage. The pitch of this diminished murmur is also slightly higher than normal because of the relative diminution of air space to solid material. It may also be accompanied by a slight roughness due to the increased flow of blood to the part and the constriction of the bronchioles by the projection of tubercles into their lumina. This same outgrowth of tubercles into the lumen may interfere with the simultaneous filling of the air cells and thus cause an interrupted, jerky, breath sound which we sometimes find present.

Consequent upon this irritation and the increased flow of blood to the part, there is a slight exudation of moisture into the air passages which shows itself as a sensation of stickiness or as fine crepitations. This sensation of stickiness or these crepitations must not be expected to be found in large areas. They may be heard only in one small spot, and then not until the patient has taken a deep breath preceded by a cough as described above. Sometimes, at this early stage, a mucous click is also heard which, perhaps, is due to mucous collecting at some point of constriction in a bronchiole and emitting the sound as the air passes through. While these departures from the normal sounds, heard on auscultation, are slight; yet, they are sufficient when other possible causes which might produce such slight local disturbances are ruled out, such as enlarged glands and tumors, to diagnose incipient tuberculosis as almost certain; and, this the more certain if clinical symptoms corroborate.

CLINICAL SYMPTOMS. What are the clinical symptoms attendant upon the invasion of the organism by tubercles? To be sure, a pathological condition which would produce so few local signs would not be expected to be accompanied by marked systemic disturbances; nevertheless, there are slight disturbances present on the part of many of the bodily organs.

Circulatory system. Upon the part of the circulatory system we note an increased pulse rate, which usually precedes the advent of bacilli in the sputum; and, when taken with other symptoms, is suggestive of the disease. Especially is this true in young people. The character of the pulse is also significant, being weak, indicating low blood pressure. Another sign on the part of the circulatory apparatus is a murmur over the subclavian or pulmonary artery as pointed out by Da Costa. This I have been able to detect in several incipient cases before other physical signs were marked and before bacilli were found in the sputum.

Respiratory system. The respiratory system shows few clinical symptoms in the very early stage. Cough may not be present at all or the patient may note a tendency to a slight hack after talking or laughing. Some observers have also called attention to the inability of the patient to take deep a breath without coughing. Respiration may be sligtly accelerated, but this sign is totally untrustworthy unless the count be made without the patient's knowledge.

Digestive system. The early stage of the disease is accompanied in many cases by disturbances upon the part of the digestive apparatus

either with or without the loss of weight. A capricious appetite or a loss of appetite which may become a total repugnance to food is present in the majority of cases. Brandenburg[1] says of the cases that present themselves for examination at the Polyclinic in Berlin, which are mostly from the hard-working class of laborers:—"Nearly all of the patients complain of loss of weight and various disturbances of nutrition. They complain of being tired, and, in spite of the weariness, the night does not bring refreshing sleep; on the other hand, they pass very restless nights."

Nervous system. The patient is irritable and restless, and his sleep is apt to be disturbed so that he awakens in the morning as tired as when he went to bed.

General symptoms. The patient tires easily, notices that work which he is accustomed to do tires him more than usual. There is not only a disinclination but an inability to do accustomed tasks.

A sign which should call attention to the lungs as, possibly, being the seat of trouble is a dilatation of the pupil. Harrington[2] in calling attention to this sign says:—"I refer to a widely dilated state of the pupils; not a paralyzed pupil, but rather one which seems to be in a more or less constant state of dilatation, due to some irritation along the track of the nerve fibres in the cilio-spinal region, or perhaps an irritation of the sympathetic, brought about by some blood change associated with very early tuberculous infection and not yet fully recognized." I have noted an unequal dilatation, with the wide pupil on the affected side much oftener than the equal dilatation of Harrington.

The patient may appear anaemic. The mucous membranes are often distinctly so, and in some cases this sign is enough to direct the attention to the chest.

Incipient tuberculosis is accompanied by a slight rise of temperature. This rise attends the formation of tubercles and the changes caused by their presence. The degree of rise is dependent, at least in part, upon the magnitude of the invasion. It usually occurs in the afternoon or after some exertion and is of great diagnostic significance; and, if accompanied by other physical signs and clinical symptoms, is to be looked upon as showing the presence of tuberculosis as most probable. This rise is not always constant. It may come at irregular

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[1]Bradenburg: *Die Lungentuberculose in ihren Anfangstadien*, Berlin, 1900.

[2]Harrington: An Early Sign of Tuberculosis, *Journal of Tuberculosis*, Vol. III, p. 6.

intervals, or may show itself only after some exertion. It usually amounts to one-half or one degree only, and can best be detected by a two-hourly chart. If this rise should persist for a variable time and then the temperature return to normal, it would not prove tuberculosis to be absent; for, after the first invasion of tubercles all reactive inflammation may subside and the temperature become normal, the disease assuming a state of apparent quiescence.

From this list of physical signs and clinical symptoms one can usually gain sufficient evidence to make the diagnosis of, at least, probable incipient pulmonary tuberculosis long before the appearance of bacillus-bearing sputum; and, as the ear becomes better trained, he will feel less need of the microscope to confirm his diagnosis; for, it must be remembered that the microscope is not applicable in incipient tuberculosis, but, only after the disease has been present sufficiently long, it may be a few weeks or a few months, to cause breaking down of tubercles with outward discharge into a bronchiole. It would not be considered an early diagnosis of an abcess, when it had broken and the products of discharge had been found to contain the pyogenic cocci by microscopical examination; yet many are content to call it an early diagnosis in pulmonary tuberculosis, when the tubercles have broken down and afforded us bacillus-bearing sputum. Why should a patient come to a physician for a chest examination if the existence of incipient tuberculosis can only be detected by finding bacilli in the sputum? It would be a means of economy to the patient when he suspects the disease to take a specimen of his sputum to the bacteriologist and find out the result for himself.

Those who are devoting themselves to the study of early diagnosis to-day are much like the child who is learning to walk, and who still clings to a chair or table or some other thing for support. They are trying to become independent of the microscope as a necessity in recognizing the presence of the disease; and, as they cease to rely on it, they gain more and more confidence in themselves. By improving their methods of diagnosis, cultivating their powers of hearing and paying more attention to clinical symptoms, they have become able to stand alone much of the time; for, a careful physical examination, made by one who is able to detect the delicate changes produced by the presence of early tubercles, together with painstaking observation and inquiry into clinical symptoms, will either detect or exclude tuberculosis in the majority of cases before the advent of the open stage of the disease with its bacillus-bearing sputum.

TUBERCULIN TEST. It is very fortunate for those afflicted with incipient tuberculosis that, in case their disease can not be detected by physical examination with the corroboration of clinical symptoms, we have other methods of examination which still make it possible to definitely decide as to the presence or absence of the disease before the advent of bacilli in the sputum. The tuberculin test is one of the most valuable methods at our command in the diagnosis of incipient tuberculosis; and, if given intelligently will prove accurate in nearly all cases. This is not and should not be made a substitute for thorough physical examination, but should be used only when the examiner is in doubt as to the diagnosis. And while I plead for a better understanding and more extended use of the tuberculin test, it is not without the warning that it should not take the place of careful physical and clinical examination. If the value of this test were to be recognized and it were to come into general use, there is a danger that physical diagnosis might suffer as it did by the introduction of microscopical examination of the sputum. But, while the profession as a whole has not deemed it necessary to perfect its powers in physical examination, but preferred to rely upon the microscope to detect tuberculosis; nevertheless, those who are most interested have been able to improve immeasurably in ability to intelligently examine chests since its use became common. So it is with the tuberculin test. It has shown us how delicate the first changes in the lungs are, and, after detecting these fine changes and having the tuberculin test verify our diagnosis repeatedly, we have learned that by perfecting our powers of making physical examinations we can detect incipient tuberculosis in that stage in which Turban says 97 per cent. should be cured. Since learning the value of this test I have been able to detect several cases of incipient tuberculosis before sputum was present; and, by appropriate treatment they were cured without ever reaching the open stage.

There is still fear on the part of many physicians that the tuberculin test is harmful. This is based upon the unfortunate misuse of tuberculin as a therapeutic agent when first introduced. In a previous paper[1], I have endeavored to show the cause of this fear, and how unwarranted it is when tuberculin is used correctly. Why are not strychnia and morphia tabooed; for, do not they sometimes cause death? Does not chloroform kill one person in every three thousand on whom it is used? Did not Professor Henoch's own son die from an injection

[1]Pottenger: "Culture Products in the Treatment of Tuberculosis," *Therapeutic Gazette*, Jan., 1902, p. 13.

of antitoxin? Do not antivaccinationists have some ground for fearing vaccination, if an occasional accident is sufficient to cause fear? Physicians are obliged to look at things in a rational manner. They know that there are certain idiosyncrasies on the part of some patients to the action of certain drugs; they know that at times accidents will happen which can not be foreseen; but yet these unfortunate occurrences should not so blind them that they can not see the value of these remedies. We ask no more for tuberculin than we do for other measures, yet we insist that it should have equal consideration.

Those who array themselves against the tuberculin test do not seem to be able to rid themselves of this fear of harm no matter how much proof is offered; yet, if these same men were to allign themselves as opposed to the use of chloroform or ether narcosis for more perfect examination or exploratory incisions, they would be laughed out of court; yet we know that there is always some danger attendant upon such procedures. There is practically no danger connected with the tuberculin test if intelligently given.

I wish here to mention the names of a few eminent physicians whose words should carry weight on this subject, for they speak from experience: Trudeau[1], von Ruck[2], Whittaker[3], Otis[4], Anders[5], Osler[6], Heron[7], McAll Anderson[8], Bernheim[9], and Petruschky[10] are all earnest advocates of the test, and show from their experiences that it is harmless when carefully given.

Anders[11] collected 3,638 cases in which the test had been given and states:—"It is worthy of note that in not a single series of cases among the many included in the tables which I have prepared is mention made of any ill effects. At all events, I have not met a single authentic report of a case in which the disease has been disseminated to distant parts of the economy with ensuing acute tuberculosis."

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[1]Trudeau: *Medical News*, June 29, 1901, p. 1013.

[2]von Ruck: *Journal of Tuberculosis*, Vol. I, p. 35.

[3]Whittaker: *Cincinnati Lancet Clinic*, 1897.

[4]Otis: *Medical News*, July 1, 1898.

[5]Anders: *Transactions of American Climatological Association*, 1900.

[6]Osler: *Transactions of London Tuberculosis Congress*, 1901.

[7]Heron: *Transactions of London Tuberculosis Congress*, 1901.

[8]McAll Anderson: *Transactions London Tuberculosis Congress*, 1901.

[9]Bernheim: *Medical News*, Sept. 1, 1900, p. 351.

[10]Petruschky: *Die Experimentelle Fruehdiagnose der Tuberculose.*

[11]Anders: *Transactions of American Climatological Association*, 1900.

The test is made after keeping a two-hourly chart of the temperature for two or three days. It is best given either in the early morning or upon retiring. The patient's mode of life during the test should be the same as when the control chart of the preceding days was taken. the temperature should then be taken every two hours beginning five or six hours after the injection. The reaction usually appears from twelve to sixteen hours after the test is given, but is sometimes delayed several hours. In one of my cases it was delayed until thirty-three hours after the injection, when a typical reaction, with malaise, chill and a temperature of 103 degrees, appeared. Although this reaction was much more violent than is usual, yet no evil results followed.

A reaction consists of two different manifestations; one on the part of the general system which is characterized by general malaise with depression of spirits, loss of appetite, nausea, headache, pain in back and legs and a rise of temperature two or more degrees above that of the preceding days; and, a local reaction, which shows itself by an increase of all the local symptoms.

The dosage and method of administration has been described so often that it is scarcely necessary to repeat it here; suffice it to say that the value of the test will depend upon the manner in which it is given. The first requisite is a standardized solution of tuberculin; for, unless we have this we do not know what we are giving; and the dose that would give a reaction one time would be inactive another. Again the test should not be given when fever is present; for under such circumstances there would be some doubt, in case of a rise in temperature, as to what had caused it. Then, finally, the test should only be given when it is impossible to make a diagnosis otherwise.

It must be remembered that, in administering the test, that a question of great moment is to be decided, so every precaution should be used to obtain the truth. If there is tuberculosis present the earlier found the better. If it is not present it is worth a great deal for the patient to know it. As the reliability of the test depends upon the care with which it is given every precaution should be taken to make the test conclusive.

ROENTGEN RAYS. The Roentgen rays and the fluoroscope are of value in early diagnosis; some observers claiming that they will show changes in the lung before any physical signs are present, others that their principal value is in corroboration of other methods and that they will not show evidences of change until it can be detected by other

means. It may be that this discrepancy in the opinions of different observers is due to each being better skilled in his own method. However, we must consider the rays an important aid to early diagnosis. Aside from the hazy condition over tuberculous nodules, a limited excursion of the diaphragm on the affected side has been noted. Beale and Walsh[1] in a recent contribution to this subject say, in regard to the limits of Roentgen diagnosis in tuberculosis—"We know that the earliest deposits of the disease are not recognizable; a certain number of tubercles must be aggregated before a shadow is noticeable. It is a conservative claim that in some cases the rays are our earliest diagnostic measure. It is equally true that when a shadow is cast the disease is no longer in the incipient stage." It would certainly seem, remembering our pathology, that, for the disease to be sufficiently evident to be detected by the rays, we would certainly find a lagging of the chest wall and a diminished respiratory murmur, perhaps of a roughened character, either with or without crepitation.

Examination of sputum. I simply mention this procedure because of the great importance it has assumed in the minds of the medical profession, not to recognize it as a measure of value in detecting incipient pulmonary tuberculosis. It will certainly give us a comparatively early diagnosis but it must not be relied upon to show anything in the initial stage of tubercle formation; for, as shown above, we do not find bacilli in the sputum until the tubercle bacilli have found lodgment in the tissues and tubercles have formed, broken down and discharged into a bronchus. The sputum of supposed early cases is usually examined in all too careless a manner. It is a long careful process to search a specimen or several specimens of sputum for bacilli when they are present only in small numbers. Often we are rewarded by their discovery just as we are about to give up the search. If we are depending upon the finding of them for diagnosis, we should never be hasty in telling a patient that they are not present if we have reason to believe that they might be. Better is it to take other methods to prove or disprove our diagnosis and withhold our opinion for the time.

I can conceive of the microscope being able to detect tuberculosis before other methods of examination, but it would not imply an early diagnosis, but rather a late diagnosis of a very small invasion. Such might be the case where the lung was invaded by a very few tubercles, so few as to cause almost no disturbance at all, and these should break down and discharge into a bronchiole; but such cases are not common.

[1]Beale and Walsh: *Practitioner*, July, 1901.

When we consider the prevalence of pulmonary tuberculosis, the successfulness of early treatment and the comparative hopelessness of treatment in the advanced stage, we are forced to the conclusion that early diagnosis is one of the most important subjects in the whole domain of medicine. Before we are able to make rapid strides in the prevention of tuberculosis, we must become more thorough masters of diagnosis. It is not a simple thing to make a diagnosis in incipient pulmonary tuberculosis; on the other hand, it is very difficult of accomplishment. It requires close observation, a well-trained ear and a mastery of physical diagnosis; but, this is something that anyone, who has determination and acute powers of hearing can attain.

Bradbury Block.

ORIGINAL TRANSLATIONS.

VIEW-POINTS AND PROBLEMS IN THE STUDY OF TUBERCULOSIS.*

BY FERDINAND HUEPPE.

Gentlemen:—In opening the present session of the Tuberculosis Commission my first undertaking will be to review critically some of the causal elements of the disease in question. Interest therein is considerably augmented at the present moment by the impression which has been called forth by Koch's paper at the recent London Congress. The resolution of this body of men to discuss at the next international meeting the subject of the predisposition to tuberculosis, is another document to the fact that our view-points in regard to this affection are undergoing a radical transformation which is everywhere in evidence.

Koch's paper has again brought home to us, and in a most astonishing fashion, the fact that deep rooted misconceptions are in force despite twenty years of labor; and that bacteriological orthodoxy, under Koch's lead, has not yet arrived at a lucid presentation of a subject which dates back to 1882, the year of the discovery of the bacillus. One might almost say that nothing has been learned during this period, while much which had been carefully elaborated before the bacteriological era has now been forgotten. From any other point of view it would be impossible to understand why Koch has sawed off the limb upon which he has been sitting.

Hygiene and bacteriology in their intimate reciprocal relations are ripe for a scientific treatment of these problems in etiology. They have claimed new view-points for the warfare against tuberculosis while older ones have been rehabilitated.

These points of view are of the sort that no man capable of forming a judgment can afford to ignore in warfare with our greatest pestilence. To desire to construct the etiology of tuberculosis out of the biology of the bacillus and animal experiment is a hopeless undertaking, because false in its premises. Whoever thinks of nothing but bacilli in this warfare has already missed the connection between the latter and the social problems of hygiene. Other circles besides our own have come to a clear understanding that one must consider the tuberculous individual himself along with a study of the bacteria in the case. This

*Address of the Presiding Officer of the Tuberculosis Commission of the Deutsche Naturforscherversammlung. 73rd session. Hamburg.

Translated for *The Journal of Tuberculosis* from the *Wien. Med. Wochenschrift*. 1902, Nos. 1 to 3.

is well shown in our present meeting by the fact that the Pathological Section has two papers upon the histology of tubercle.

Baumgarten still looks at matters from the purely bacteriological standpoint; for he regards the differences in the histological structure of tubercle as dependent exclusively upon the virulence of the bacteria, and looks upon slight virulence as equalizable only through an increase in the number of bacilli. This factor certainly coöperates in a marked degreee, but we must not lose sight of the fact that this reasoning is based somewhat upon analogy—for example, with that of the behavior of the anthrax bacillus. Thus far we possess no means of fashioning the virulence of the tubercle bacillus at pleasure, and can neither increase nor diminish it. On the other hand, we often obtain our first idea of virulence from the histological findings.

A count of living bacilli has as yet never been made. Our quantitative appreciation of the germ has been in connection with dried bacilli, only partly controlled. We do not know how many of the latter are dead or non-virulent. Nor can we determine how many are alive and infectious. The sole method of counting living and virulent bacilli which is known to-day has been recently worked out in my laboratory by Welemmsky, and has not yet been published.

We must further consider that as far as testing the virulence is concerned, we have no *tertium comparationis.* Even our little experiment animals—guinea pigs and rabbits—often show marked individual variations. By passing the bacillus through animals it may be made extremely infectious for a particular species—the hen for example—but it has meanwhile lost its virulnce for the rabbit. The fact is often overlooked that virulence is only a relative term and does not comprise all the factors which are of importance for an act of infection. The infectiousness of a pathogenic microörganism depends upon its entire metabolism in relation to the species of its host. One sided emphasis of virulence can, under certain circumstances, lead to erroneous conclusions. Virulence and amount of poison alone do not explain why we have in one case pure phthisis without local findings, in another pure tubercle, and in a third—and without associate infection—that solution of tissue which may amount to the formation of cavities. Baumgarten has produced the latter experimentally in rabbits and I, myself, once in the dog.

These early findings in tuberculosis were illuminated further by observations on the part of Behring who found that solutions of diphtheritic virus with a unit of volume sufficient to kill an equivalent by

weight of the mouse, exhibited an entirely different degree of toxicity toward the same amount of weight of pigeons, rabbits, goats and horses. Thus the same conditions are seen to obtain in diphtheria and tuberculosis, and the action is not due alone to virulence and to the amount of determinable free virus, but also to other substances which may raise or lower the virulence and toxicity.

Orth has, in my opinion, done better in some respects, for after duly considering the virulence and number of germs he recognizes the presence of an unknown residue which can be explained only by peculiarities in the tissues themselves. Without considering the local predisposition we cannot explain those cases in which the bacilli are virulent and invasive and able to set in motion the phenomena of disease.

In order to make this great difference clear it is not necessary, as Virchow has done, to contrast human tuberculosis with the *perlsucht* of cattle; it is sufficient merely to study the different phases of the disease in man. According to the tissue in which the bacillus produces its lesions, we see either submiliary or miliary nodules, or a more diffuse infiltration. We see, for example, cutaneous tuberculosis and lupus side by side; we also see scrofula and fungous arthritis. In the lungs we observe miliary nodules and infiltration. Occasionally we see in man the lesions of the *perlsucht* of cattle—as in a case reported by Meltzer under the designation "perlsucht of the pericardium." The histological elements—miliary tubercles, round cells, epithelioid cells, giant cells, vary notably and their retrograde changes likewise exhibit much variation.

While diptheria is to be regarded as an infectious disease and diphtheritis as a local necrotic process, we understand by *tuberculosis* a specific infectious disease, and by *tubercle* an anatomical nodule which can be produced by the most heterogeneous irritants and which demonstrates nothing beyond the fact that the mechanical make-up of the tissue is especially adapted for the formation of nodules. The *virus* of Buhl and Cohnheim has been replaced since 1882 by Koch's bacillus.

The anatomical conception of tubercle of Virchow is either too narrow or too broad, and in no wise satisfies our necessities; and in this comprehension of the matter, Orth's views meet those of the hygienists. The conception is too narrow if one is led to believe that he can pass directly from the morphology of the lesion to its etiology and thereby isolate a disease. On the other hand the conception is too broad if one is led to overlook the fact that these nodular lesions are produced by the greatest variety of infectious and non-infectious

diseases. One cannot see in tuberculosis more exquisite submiliary tubercles than those which are produced in the inoculated type of glanders in guinea-pigs. The perl-node is also a genuine tubercle of the same class as the submiliary variety; with lympho-sarcoma it has naught in common, despite Virchow's assertion to the contrary. The typical feature of the perl-node is not its structure, but its retrograde metamorphosis, its calcification. This is the rule in cattle, in the pleura, pericardium and peritoneum, but not in other localities; but even in mankind we may exceptionally meet with genuine perl-nodes.

The statement of Koch that the bacillus of bovine tuberculosis does not attack man has nothing whatever to do with the question of the nature of the perl-node. Different exciters of disease may produce the same histological formations; and *vice versa* one bacillus, acting in different hosts or even in different tissues of the same host, may engender entirely different histological lesions.

But the subject of tubercles does not exhaust tuberculosis; nor do retrograde metamorphosis, caseation and calcification; for in the same lung, along with tubercles, caseation and calcification there occur superficial exudative, inflammatory processes, as Orth in particular has told us. The extraordinary multiformity of the histological picture of tuberculosis even in man alone—which is hardly less than the multiformity seen in syphilis—shows most strikingly that the local predisposition must play the decisive rôle in infection with the tubercle bacillus. It is a source of great joy to me personally that a pathologist like Orth, sustained by a rich histological material, should represent the view which I first promulgated in 1889 and presented more comprehensively in 1893.

Virchow's distinction between tuberculosis and caseous pneumonia was always highly unsatisfactory from the clinical standpoint and did not even suffice for an anatomical differentiation, when we bear in mind the multiformity of the phenomena. The physician who has to treat living individuals and who regards the results of autopsy as but a single criterion desires etiological unity along with anatomical multiformity, for otherwise he cannot comprehend the disease. In this sense we have through Klencke, Villemin, Buhl, Cohnheim and Salomonsen and above all, by Koch, attained the old conception of the unity of tuberculosis which Rokitansky upheld, but which we can now understand as dependent upon the existence of a specific disease.

It is not without interest to note the manner in which the orthodox bacteriologists seek to evade certain of these facts. Thus Koch will see

nothing which has happened in the last twenty years; he does not or will not know anything beyond the bacillus. The bacillus is everything! But Koch had much clearer views between 1882 and 1884 than he has to-day; for originally he recognized a predisposition, while now that is a thing of the past since Cornet's labors. Baumgarten has confessed that the resistance of the organism is of significance along with the virulence and number of the germs.

For Flügge the predisposition which had once vanished is now slowly returning. In his most recent work he defends the bacteriologists from the reproach that they do not recognize a predisposition:—"They have always recognized the predisposition as the second factor." This view, however, shows, in itself, that Flügge has never really taken cognizance of the nucleus of the matter; and Flügge of all Koch's disciples is probably the most devoid of prejudice.

Such transformations in the representation of a subject must show that no one can hereafter dispense with the scientific consideration of the problems of etiology which must be established in the interest of the development and continuity of our science. This is shown by the universal antagonism which greeted Koch's announcement of his views in London, and this, in despite of his authority. The facts were not denied, but the interpretation vouchsafed by Koch was a complete failure.

In a problem as complicated as that of the etiology of and warfare against tuberculosis, where the course of the disease must be mapped out by the clinician and the status at the time of death by the pathologist, and where by the side of the purely medical element the most complicated social relations have importance, it appears to us frivolous to seek the etiology and extermination of phthisis through animal experiment.

Even the evolution of bacteriology should warn us to be cautious. At first Koch denied statements to the effect that other bacilli than his possessed the same tinctorial qualities, and asserted that such findings were due to imperfect technique. We know now that the former statements are true.

Upon the etiological side of the question Koch was more cautious. Even in 1884 he discussed the probability that differences would be revealed between the bacilli of human tuberculosis and *perlsucht*, although he had first thought them identical. However, he thought at that time, that if several species of his bacillus did exist, we must still regard the bacillus of *perlsucht* as highly suspicious. He then

continues:—"From the standpoint of hygiene the same measures must be adopted as in human tuberculosis, as long as it is not proven that man cannot be inoculated by the contact of *perlsucht* bacilli with cutaneous wounds, or cannot contract the disease by inhalation or ingestion."

Now the possibility of wound infection from the bacilli of bovine tuberculosis is assured beyond doubt; and this sort of transmission has all the force of an animal experiment. A few days ago in Hamburg an action at law revealed the fact that a man had inoculated his right arm with tuberculosis while slaughtering a consumptive cow. Prof. Heller will report at the present meeting an analogous case witnessed by himself, and others are to be found in literature. In 1900, Birch Hirschfeld demonstrated in Prof. Suttler's ophthalmologic clinic a case of tuberculosis of the conjuctiva in a man who had long milked a consumptive cow. The possibility of such transmission, disputed by Koch, has now been completely demonstrated; and even as far back as 1888 Weisser investigated a case of inoculation of a veterinary surgeon with bovine tuberculosis, and utilized Koch's own laboratory for the demonstration. This case is mentioned by L. Pfeiffer in the *Zeitshrift für Hygiene*, 1888, III. p. 209. The bacilli of bovine tuberculosis are therefore able to attack adult human beings, and the cases cited have all the vigor of animal experiments. As in localized cutaneous tuberculosis from bacilli of human origin, the lesions are accessible to treatment, so in these cases of inoculation from cattle, the disease yielded readily to local therapy.

Unintentional exepriments in inhalation of the bacilli of bovine tuberculosis are not yet known among human beings; at least I can find nothing of the sort in literature.

On the other hand there has been plenty of observation of the ingestion of food-products from infected animals. In this connection cautiously compiled statistics are available. Recently I called attention to the fact that a great difference exists in this respect between children and adults.

We know that tuberculosis in the child differs much from the same affection in the adult in regard to the organs implicaed; thus the intestinal localization is relatively infrequent in the adult and extremely common in children. My personal material shows that from 25 per cent. to 30 per cent. of all deaths from infantile tuberculosis are due to the intestinal localization. Prof. Heller will inform you later that carefully compiled statistics in Kiel show that 30 per cent. of intestinal tuberculosis occurs in children, and but 2 per cent. in adult life.

It appears to me that we overlook the fact that the primary focus of the disease does not necessarily represent the locality at which the virus entered the body; this focus may simply mean a *locus minoris resistentiae.* It is therefore quite possible for infection to occur by way of the nourishment without the production of a local lesion in the intestine. Tubercle bacilli may possibly be taken up in the tonsils and borne by way of the blood and lymph streams to the lungs and pleura, there to cause the initial lesion, which is then set down falsely as due to inhalation. Such possibilities have been shown by careful experiments and cases to be facts.

Koch's own researches are conclusive on this point. He fed bacilli-bearing sputum to pigs and after an interval of 3 1-2 months, 5 out of 6 animals showed tubercles in the cervical lymph nodes, while in one case the same lesions were found in the lungs. He then fed 6 other pigs with material containing bovine tubercle bacilli. Three of the animals died and the others became very ill.

Cases of primary intestinal tuberculosis occur in minimal figures, because the point of entry of the virus does not coincide with that of the primary lesion. Even if certain of these cases are due to ingestion of tuberculous sputum from the mother or nurse accidentally mixed with the nourishment, in by far the greater number of cases the infection must proceed from the milk of tuberculous cows. Hence just as the bovine disease may be inoculated in the human skin, so may it also affect the human intestine. There can be no question of immunity, of a natural resistance of man towards the bacilli of bovine tuberculosis—neither in childhood nor adult life.

In regard to the reception of bacilli in the air passages, it is certain that there exists a primary inhalation-tuberculosis. We must acknowledge as a result of Koch's old and Flügge's recent experiments with droplet-inhalation that primary tuberculosis may develop in the air pasages; and we must seek to protect ourselves from this source of danger. We must likewise reckon upon the possibility that inhalation-tuberculosis may not begin in the air passages, but in the intestine. A consideration of all the factors, however, would appear to show that such a mode of infection would hardly be the rule in children (A. Gottstein).

It appears to me in regard to protection from spray-infection that Flügge has allowed a healthy human understanding to assert itself once more. The handkerchief must again be brought into play, for the pocket spittoon cannot answer all the demands. No one should

cough without a handkerchief before his face, as a matter of common decency. Some sputum must adhere to the lips and beard and be wiped off by the handkerchief, but Cornet's crusade against the latter appears to be overdone.

On the other hand we must admit from experiments made in my laboratory and from the communications of Aufrecht and Ribbert that primary foci of tuberculosis may occur in the lungs.

I have but recently known of Baumgarten's success in causing primary hematogenous tuberculosis by infection through the urinary bladder. Neither inhalation nor mechanical conditions in the apex, but a specific weakness of the tissues in that locality was the determining factor in this phenomenon. From this experiment Baumgarten must at last admit the existence of a sequence which I have recognized since 1889, but which he has hitherto denied.

In regard to natural immunity we now know as a result of the study of hemolysis that the active fluids of man and the ape behave in a very similar fashion. Tuberculosis of the anthropoid apes, in fact, constitutes a connecting link and Mr. Grünbaum will demonstrate before this meeting pathologic specimens from a chimpanzee which was infected from the milk of a cow with bovine tuberculosis. If recent studies appear to show that bovine tuberculosis is transmitted to man with difficulty—or not at all if Koch is right—while the human form of the disease infects cattle with the same reluctance (other experiments of Bollinger and Chauveau contradict Koch's findings), the explanation should lie chiefly in the substratum of tissue which becomes infected. Every kind of organism has acquired a certain degree of resistance, upon which depends the reaction awakened by the disease-germ. This substratum then determines the type of disease and not the dose of virus, or the difference in site of inoculation as Koch claimed in 1884. These last named factors will not of course be neglected, for we see daily that the guinea-pig which almost never develops tuberculosis spontaneously may be infected artificially at pleasure.

We repeat that the substratum, the soil, is by far the most important factor; this has been shown by Karlinski, who exposed cattle to the bacillus of human tuberculosis in 25 experiments, 10 of which gave positive results. He established thereby the fact that Bosnian cattle exhibit a peculiar susceptibility to the disease. Koch has paid too little attention to the element of breed in his animal experiments.

The nucleus of a scientific conception of the disease is variability of resistance, which depends upon many factors, such as social relations,

food, education, inheritance, etc. Certain disease germs, especially adapted for the purpose, are able to engender maladies through arousing the resistance, congenital, or acquired, of the tissues. Koch who has failed to keep in touch with the work of the last twenty years still looks upon the bacillus as the disease itself.

One bacillus is pathogenic to man, another to cattle, a third to the pig. This relative constancy doubtless comprises differences. We have known this of avian tuberculosis for years. Fischel and myself described it in 1891 to 1893; Arloing, Courmont, and Dor in 1891, and more recently Nocard. Differences in the virulence of the bacillus of bovine tuberculosis were recognized by Frothingham in 1897 and Th. Smith in 1898. The latter found that the virulence of the bacillus differed in different mammals. Baumgarten and Gaiser, myself, Arloing and Nocard have demonstrated the different behavior of the bacilli in different nutrient media. The view that the bacillus is purely active and the tissue passive has been refuted. In cattle the bacillus is made to change its shape and to become more pointed. Both myself and Smith have noted the resemblance in sections to the lepra bacillus.

Every observer must have noted in sowing cultures of the human bacillus that differences assert themselves. The same germs kill a guinea-pig rapidly, but cause only a local lesion in rabbits. Bacilli from human lupus cause a local lesion only in the rabbit; while bacilli from pulmonary lesions quickly destroy the same animal.

I attach little value to the fact that a positive tuberculin reaction is obtained in both man and cattle; for with Büchner and Römer I do not regard the phenomenon as specific, in the sense that the bacteria produce specific poisons. Under these circumstances the question of the existence of a predisposition to tuberculosis is permanently settled. There is such a disposition, not only in the racial but also in the individual sense, and the great differences in the histological findings are the key to the demonstration of the validity of these assertions. This phase of tuberculosis I regard as of such importance that I have proposed it for discussion at the present meeting of our Commission.

As the Pathological Section of the Society is to discuss the histology of tubercle, I have made an agreement with Prof. Martins, that on account of the great extent of the subject matter it would be best to limit ourselves to a single feature, viz:—heredity.

What is usually regarded under this term may be characterized with few exceptions as useless rubbish. Koch denies the influence of

heredity, while Baumgarten is equally positive that heredity is everything. One sees in heredity the substratum which is formed after the union of the spermatozöon and ovum; another the direct transmission of the disease-germ; a third sees only intra-uterine infection. These different views illustrate the necessity of bringing some approach to order in the entire subject of predisposition. Everything depends upon a proper statement of the problem, given in a concise form.

But how many things must be first considered! Strictly speaking but one condition, one peculiarity can be inherited. A bacillus thus propagated is not a disease, and a disease is not a condition but a process. A disease can be congenital, but not inherited.

In a given family every child as it attains a given age—the same in each instance—becomes tuberculous. In another family the children develop the disease at widely different ages, and some escape altogether although the parents are tuberculous. The question thus answers itself falsely. In compiling statistics we usually note the extension of family disease from the parents to the children, but we make thereby very little headway in the problem of the heredity of tuberculosis.

If we consider etiological factors in association with histological findings we recognize the existence of a particular weakness in certain cell-areas, tissues and organs. We know, however, that various germs can set up disease in such debilitated tissues, so that we have to take account of all other affections in a consideration of heredity.

Hitherto, we have considered diseases like influenza, whooping cough, and measles solely from the standpoint of nosoparasitism. Liebreich has recently given us a definition of this latter term which makes it perfectly clear. All of us formerly understood it to mean that upon a nosos, i. e. an anatomo-elemental type of disease, a second disease, especially tuberculosis, is grafted. Liebreich, however, succinctly states that the *nosos* is an unnecessary conception, that it represents nothing more than the disposition to disease. Therefore the word *nosoparasitism* should be eliminated form pathology.

In a certain sense, however, the expression is just. There is no doubt that tuberculosis often develops after previous acute or chronic affections, catarrhal and otherwise. This nosos when parasitic is an example of metabiosis, but it need not be an infectious disease. Thus tuberculosis may also develop after persistent inhalation of dust has produced lesions. This is genuine nosoparasitism, i. e. actual infection with tubercle bacilli as a sequel of previous injury to the tissues. In

this sense a number of conditions must be brought in connection with tubercle bacilli. The same is true of mixed infection—symbiosis—which plays a great part in the destructive phenomena of lung disease.

But there is still a third group which has almost escaped observation. Thus I observed in 1887 a certain vicariousness among the infectious diseases. Thus one contagious affection appeared to give way to another. Reger has called attention to the same phenomenon. Riffel in the course of extraordinarily painstaking investigations has established the fact that the disposition to tuberculosis must be understood more in the vicarious sense. In addition to the infectious diseases mentioned above we should consider diabetes, arthritis, carcinoma, heart-diseases, and alcoholism—affections which while they enhance the disposition to tuberculosis also act vicariously with it. Thus Reibmayr speaks of "transformed" tuberculosis in pointing out that in England heart disease and cancer have increased in almost the same ratio that tuberculosis has diminished. At first sight cancer does not seem to belong to this group of diseases; but the middle germinal layer must sustain some alteration before the epithelia can proliferate into it in a pathological sense.

In the transmission of the substratum of disease it is not necessary that every child who is threatened with tuberculosis should actually develop the disease. He can contract some other affection through the vulnerability of his tissues and either die from it or be immunized against further attack from the tubercle bacillus. It is probable that we can give to this vulnerable soil a second nature through hygiene and education and thereby protect a threatened child. As Hirsch says, we can seek to relieve an individual of his hereditary burden and at the same time antagonize paralyzing pessimism in therapeutics.

In short, when we deal with the heredity of tuberculosis we must do more than ask if the child's father was tuberculous, or if he used to cough. We must go into details along the lines of research which we have just enumerated.

This subject of heredity does not of course exhaust the duties of our Commission. Tuberculosis is a veritable endemic pestilence, and, in its extension, a social evil of the gravest kind. The old contrast between city and country, accentuated more than ever to-day, leads the rural dweller to the town, and not only the more energetic and ambitious but those who are physically vulnerable. Some of the latter although they look healthy often succumb quickly to tuberculosis as a result of inability to become accustomed to town life. This is in no wise due to

increase in the possibilities of infection. There are plenty of ways to contract the disease amid the careless life of farmers. It would be impossible to acquire suddenly the disposition to tuberculosis after moving to the city and leading an urban life. The exodus to town even favors the weaker rural dweller by removing him from the hard struggle for existence, which often destroys both parents and children at early ages. Individuals doomed thus to perish if they remain in the country come to town and enter upon a different kind of struggle for existence. They are naturally ailing and ultimately fall a prey to tuberculosis, a very slow but certain method of weeding out these weaklings. Herein lies one phase of the social peril of tuberculosis.

We must combat the indifference, the want of cleanliness, the imperfect comprehension of the benefits of air and light on the part of the masses. The notion of hygienic education of the people is the entering wedge in the warfare against the disease. Patriarchial benevolence is not our watchword; we must teach the units of society their duty to the community as a whole.

HISTORY OF THE DEVELOPMENT OF JOINT-TUBERCULOSIS.*

BY F. KÖNIG, BERLIN.

Gentlemen:—Tuberculosis of the bones and joints was as good as unknown during the first two-thirds of the past century; and even those from whom one had the right to expect exact knowledge upon these subjects were in complete obscurity as to the affections which have since been recognized as bone- and joint-tuberculosis. When I, a young surgeon, inquired of the old surgical masters as to why operations for white swelling of the knee healed so badly or not at all, they could give me no answer. The idea of "scrofula" was paramount at the time, and such joint-affections as fungus, tumor albus, etc., could be explained upon no other supposition. To-day there is hardly a surgical affection which is so well understood in regard to its origin and course as joint-tuberculosis.

I shall endeavor to illustrate to you by means of specimens a picture of disease which could hardly be duplicated by any other surgical affection.

The first glimpse of light in regard to the nature of *white swelling* was due to a seemingly very unapparent discovery by Köster of Bonn,

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who found tubercle in the granulations produced by this affection. To this finding, repeated shortly on all sides (and incidentally by myself) were added the results of further investigations which were made in Volkmann's clinic at Halle, and which gradually established the fact that an entire series of tumors and ulcers formerly regarded as "scrofulous" or "dyscrasic" presented the same anatomical qualities and that tubercle was to be found here as well as in lupus. At first sight it appeared as if a special group of affections had been evolved—a so-called "tuberculoid" which stood in close connection with genuine tuberculosis —for the picture which had obtained in regard to the latter did not seem to be identical with that of the new group. In due time, however, the "tuberculoid" affections became recognized as actually tuberculous processes.

Richard Volkmann established a highly important truth in joint-pathology when he showed that certain peculiar foci of disease already described by other observers—particularly French surgeons—were especially common in joint-tuberculosis. These foci which are seated in the osseous portion of the articulations and to which we shall allude from time to time, develop at times in such a fashion that they do not come in direct contact with the joint; while again—and here lies their great significance in the development of joint-tuberculosis—they may enter the articulation either by breaking through the cartilaginous lamella of the articular surface or the insertion of the capsule of the joint. In this way the infectious substance of the disease enters the articulation which thereupon becomes tuberculous; while the original osseous foci of the disease are likewise examples of tuberculosis.

If we review all that has just been said we see that proofs are supplied of the presence of tubercle-granulations in very many cases previously described as scrofulous joints, white swelling, etc., and of the coëxistence in the great majority of cases of osseous foci with the joint lesions which are not only tuberculous in themselves, but from which the joint lesions become evolved. At this stage in the advance of our knowledge of the subject I was able to show in a series of papers that tuberculosis of the synovial membranes was a regular and inevitable lesion in the joint-disease, and not a mere chance occurrence. I further established the tuberculous nature and relative frequency of the osseous foci and how often primary synovial tuberculosis might occur with previous lesion of bone. Thenceforth a distinction became inevitable between primary synovial and primary osseous tuberculosis.

I proceeded from the special to the general and demonstrated by numerous autopsies that joint-tuberculosis might occur as a primary and isolated lesion in 20 per cent. of cases; which number is perhaps somewhat too high, for we now know that, as a rule, the disease is present elsewhere in the body and that some of our early autopsies must have been defective. Tuberculoses of the lungs, bronchial glands, kidneys, etc., usually coëxist and the joints become involved secondarily thereto. Sustained by these facts, I argued long by word of mouth and in my writings that scrofulous joints must be tuberculous, but much time went by before the truth of my contention was admitted. And although the entire doctrine was elaborated in all its details, demonstrating both the nature of the joint-disease and its connection with tuberculosis as a whole, the discovery of the bacillus was required to clinch the matter. After this event all oppposition was withdrawn, and the joint-disease long known as white swelling, strumous arthritis, etc., was recognized as tuberculous.

I will now proceed to sketch the picture of tuberculosis of the synovial membranes and articular ends of the bones in the most concise manner possible, paying no attention to tuberculosis of other osseous structures. In the great majority of cases the bones and synovial tissues are involved jointly.

White swelling, fungus arthritis or whatever name we may choose to give it has to-day a very transparent history, which enables us to understand why this disease appears in such a definite form (which constancy of type once gave it the clinical term of "scrofulous joint"). This clinical condition became intelligible only after we had learned that the characteristic spindle-shaped joint without effusion *must have once passed through a period in which effusion had occurred.*

Even in my earliest communications on tuberculosis of bones and joints, I had isolated a group of affections under the term tuberculous hydarthrosis. Only the most marked forms of dropsy were thus designated—forms which from the extent of effusion had not originally been reckoned as tuberculous, but simply as chronic dropsy of the joint with gradual origin and evolution. It was known of this condition that it sometimes ended in resolution while in other cases it became a scrofulous joint. Later studies and especially some of my own in looking over pathological specimens led me to the recognition of the fact that every case of joint-tuberculosis is preceded by a stage of effusion or, in other words, by a tuberculous hydrops. Persistent effusion, however, is seen only in a minimum of cases.

From the initial sero-fibrinous synovitis the various stages of white swelling are developed for us to-day in a perfectly intelligible manner; the disease becomes clear to us only through the knowledge that at the outset of every synovial tuberculosis, there is an exudation into the sac —in other words, a sero-fibrinous synovitis.

I shall first consider synovial tuberculosis, the course of which is the same whether or not there is a coincidence of osseous tuberculosis.

The entire course of the affection is such as to indicate that the inflammation evoked by the bacillus is exudative, sero-fibrinous in type. But the proportion of the fluid and coagulable element (fibrin) is not constant for different joints; for sometimes we see much fluid and but little fibrin, and on other occasions the reverse. The changes in the affected joint appear to depend solely upon the amount and behavior of of the fibrin which is responsible for the greater part of the destruction; since the processes of cicatrization and healing are effected through this substance.

By the term *fibrin*, as used in this connection, we understand a precipitation which occurs in the effusion, and which may appear as flocculi or in definite form, such as rice-grains, melon seeds, amylaceous bodies or even in the most varied polypoid formations (tongue, cock's comb, etc.). This precipitate either adheres to the articular surface or becomes organized after a time into polypoid tumors. This collection shows how manifold is the picture which may be constructed from the grayish-white coagulable substance.

The type of exudate which becomes organized possesses the greatest significance for the synovial membrane, and as we shall see later, many of the characteristic local phenomena are developed from this source.

The development of synovial tuberculosis may be studied of course in any joint of the body; but the process first became clear to me from the study of the knee. I am therefore of opinion that whosoever desires to investigate this subject should have specimens of knee-joint tuberculosis at hand. The anatomical and physiological conditions of the patella tend to render study of the knee-joint especially instructive.

The conditions which I shall demonstrate to you are not present in the same degree in every case. There is a certain number of joints in which the liquid exudate preponderates over the fibrin—for example when the joint is simply attacked as a local manifestation of acute, general, miliary tuberculosis. Here we see tubercle deposited in the unchanged synovial membrane although under ordinary circumstances

it is not common to see this early deposition into the membrane itself, for this phenomenon takes place in the *layer of organizing fibrin.*

This sort of precipitation, however, is not peculiar to tuberculous joints, for it occurs likewise under other circumstances in which a fibrinous exudate takes place. It is rare, however, for any other affection to produce such quantities of organizable fibrin as occur in tuberculosis.

This may occur, however, in gonorrhoeal and other forms of acute and subacute inflammations of the joints, and especially in haemarthrosis, where repeated recurrence of the haemorrhage adds to the amount of fibrin poured into the joint. Although the conditions in haemarthrosis differ somewhat from those of simple inflammation—since the blood-coloring matter plays a rôle in the alterations of the joint—they are sufficiently similar as far as the deposition of fibrin is concerned.

The tuberculous joint differs from all others as follows:—While the fibrin is being deposited layer by layer upon the cartilage and synovial membrane and is there undergoing organization, tubercle appears in the latter, upon the margin of the joint cartilage. To this rule there are but few exceptions. At first we see round-cell tubercle, which appears coincidently with and in connection with the newly formed vessels. In this deposit of tubercle we see the germ of those special alterations which characterize the tuberculous joint, such as caseation.

The mere precipitation and organization of fibrin with the resulting alterations in the subjacent tissues are not dependent upon the formation of tubercle.

Let us now consider what takes place in the knee-joint in synovial tuberculosis. Here the fibrin is always deposited in quite definite localities. The femoral surface may be selected as the most characteristic. Smooth layers of fibrin begin to appear upon the patella at either side which unite in the middle; while, at the same time a similar deposit takes place at the periphery of the cartilaginous surface of the condyles. The fibrin layers increase in breadth and depth, spreading over the various articulating surfaces until but minimal portions of the latter remain uncovered. In regard to individual details, which have much significance for the knee-joint in particular, we must forego further discussion and must likewise omit the description of the deposit of fibrin upon the articular surfaces of the tibia. A general idea of the process is what we wish to suggest in this connection. It is only necessary to add that the organzation of the fibrin, as well as the tuberculization, likewise takes place from the periphery inward.

At this period, moreover, the organizing substance exerts its most deleterious action upon the subjacent tissues. As long as the tuberculous process is active, and the deposition of fibrin continues, a pernicious action is exerted upon the cartilage which becomes eroded, and subsequently, as a result of the destruction of the cartilage, upon the bone itself.

If we scrape off these fibrinous deposits, the subjacent cartilage is found to be uneven. It has lost its smoothness and presents depressions of various degrees of depth, into which the newly formed tissue has grown. By this process the cartilage becomes progressively eroded. The losses of substance increase in depth and width, leaving islets of cartilaginous substance intact, until the newly formed tissue has reached the level of the bone, into which tissue analogous loss of susbstance begins to occur. If a tuberculous focus had preëxisted in the bony tissue it is naturally exposed, so that the corresponding portion of the joint is relatively destroyed. Further discussion of this interesting phase of our subject must be neglected here as it is without special bearing upon the general principles involved.

If the deposit of fibrin upon the cartilage and its subsequent organization are capable of accounting for the various changes which affect the thickness of the articular ends of the bones, they are not less equal to the task of explaining the changes in the synovial membrane. The granulation-process which occurs in the joint capsule is not a direct product of the synovial membrane, but is the result of the precipitation and organization of fibrin. The synovitis is therefore not synovial at first but parasynovial, and the first formation of tubercle occurs likewise in these superficial strata. Only at a later period do the conditions of irritation and proliferation occur in the synovial membranes proper, and the deposition of tubercle then takes place in the same structure. This fact is of great importance in the prognosis of arthrectomy and resection, and accounts for the failure of the synovial membrane to disintegrate and degenerate, although thick masses of tuberculous granulation-tissue can be detached therefrom.

If the process just described is arrested, the site of the progressive destruction is indicated by a contracting scar. That is true of course, only for the synovial membrane, for the lost cartilage and bone are not replaced.

When these joints, as already studied by us, assume at the onset the characters of an "hydrops tuberculosis" by reason of the volume of the liquid exudate, they become altered in form and characteristics, as a

result of the deposition which thickens the capsule. Fluctuation is then still apparent, although the sac which contains the fluid is thus thickened. The effusion gradually disappears until at last, only the thickened sac remains behind. The character of the swelling changes and the joint dropsy becomes a white swelling with its spindle-shape. It is of course self-evident that this course of disease may be modified by local irregularities, such as the amount of disintegration, cicatrization, intercurrent suppuration, coincidence of primary osseous foci and the like.

When everything is taken into account, we can understand the characters of the deviative forms of this affection, and also the points of similarity between the tuberculous joint and gonorrheal synovitis, which has a stage in its evolution suggestive of the former malady. We are also in position to understand why haemarthrosis is so readily confounded with the tuberculous joint that the surgeon is sometimes influenced to the performance of a fatal resection.

Now for bone-tuberculosis proper! The relation of the diseases of the bones to those of the joints is simple; they were understood before we acquired our knowledge of synovial tuberculosis. We know from Volkmann that tuberculous foci in bone occur in the neighborhood of the joints. These focal lesions develop essentially in two forms:—

1. A more or less rounded or tubular osseous defect which is filled with caseating tubercle-granulations, and perhaps with small tuberculous sequestra. Such defects occur throughout the spongy tissue of the articular ends of the bones. They need not communicate with the joints, but may become fully encapsulated, and remain thus for years. As a rule, however, they do communicate with the joints, either by primary extension or because they have been exposed by the destructive action of the synovial tuberculosis. A certain number of these primary osseous foci rupture externally and set up para-articular abscesses which may in turn extend into the joints.

2. The tuberculous infarct: The broad side of this lesion is turned toward the cartilaginous surface (in childhood we sometimes see the base of the wedge turned toward the epiphyseal cartilage).

The joint infarcts chiefly interest us here. They are distinguished by a triangular form and by a peculiar grayish-white or yellowish quality of the surface produced by the saw, from which in characteristic cases small quantities of cheesy pus are evacuated. The osseous infarct, as a rule, is not softened and hardly altered in its gross outline; even at the periphery there is hardly any liquefaction and solution. In many

cases it is indeed possible to pry it out wth an elevator pushed in at its margin. Otherwise it remains firm, intimately united to the surrounding tissues; so far from being a sequestrum of the type found in acute osteomyelitis, it is united thereto by many osseous trabeculae and blood vessels. Differing much in size and shape, it does not lend itself readily to Röntgen photography, and at most a dark shadow of the periphery of the infarct is obtainable.

3. To the two preceeding types we may add the infiltrating form, in which the morbid process extends into the bony tissues by means of the Haversian canals. In its most exquisite type it extends from the diaphyses of the long bones to the epiphyses. This type represents a highly metastatic tuberculous infection, and as distinguished from the two preceding may spread without limitation. Many cases of this sort which attack the vicinity of the articular surfaces remain entirely superficial. The graver type sometimes gives a bad prognosis in cases of resection.

Generally speaking, the development of tuberculosis in bone is not necessarily associated with joint-tuberculosis, but is dependent upon the nutrient vessels. Types 1 and 2 already described may be produced artificially in animals by injecting tuberculous material in such manner that it enters the nutrient vessels of the articular ends of the bones.

My former scholar and assistant, Dr. Müller of Aachen, has shown that both these forms may be imitated by injecting tubercle bacilli into the bone-arteries. In an osseous focus thus produced the localization determines whether or not the joint is likely to be involved.

I have shown repeatedly that Volkmann's original axiom has been confirmed. Synovial tuberculosis arises in these cases when the osseous focus breaks into the joint, distributing thereby caseous masses and tubercle bacilli.

A few brief general remarks now remain to be added. I have found, as already stated, that in 20 per cent. of autopsies the joint-tuberculosis was isolated. It may, nevertheless, be objected that in such cases the coincident foci of disease were overlooked. In any case, secondary foci must be far more common than primary.

Aside from those forms in which the joint-lesion is an incident in the evolution of general miliary tuberculosis, primary foci in the lungs and bronchial glands are usually at fault. Other organs are sometimes first involved, for example in caseous degeneration of the kidney. In the latter case the joint-tuberculosis may be multiple, so that clinically a renal affection is followed by an apparent polyarticular rheumatism.

Any other gland, and especially the granular structures of the abdominal cavity, may occasionally be primary to joint-tuberculosis.

When the bone is affected primarily, infection must have occurred by way of the arteries. I must admit, moreover, that I can conceive of a primary synovial tuberculosis only as having been derived from the terminal arteries of bone.

In conclusion, I have given my views of the evolution of the anatomical conditions of joint tuberculosis in a somewhat broad manner in order that you might not forget what severe and hardly reparable disturbances of the joints are thus caused. Conclusions may readily be drawn as to the course of these affections if definite conditions are postulated. A large infarct is hardly curable, while small lesions may disappear of themselves, heal with scarring or simply remain encapsulated. For the resulting deformity too much dependence must not be reposed in orthopedics. It is for the surgeon to decide as to whether bloody or bloodless methods are indicated in a given case.

REVIEW OF CURRENT LITERATURE.

STATISTICS ON THE SPREAD OF TUBERCULOSIS.

Gottstein (*Münch. Med. Wochenschrift*, Oct. 8, 1901.) discusses the truth of Koch's doctrine of the nonidentity of human and bovine tuberculosis from the standpoint of statistics, and the comparison of the mortality percentages of breast-fed and bottle-fed children. He admits that four sources of error have to be excluded in making these comparisons: viz. defective autopsy reports, defective registration of cause of death, latency of tuberculosis actually contracted, and variability in resistance to infection.

Despite these very great hindrances to the application of the statistical method to this question, the temptation to test the material of the city of Berlin—where these sources of error act with minimal force—is too great to be disregarded. The second source of error, which has to do with the actual cause of death, is the principle stumbling-block in the Berlin material, since numerous deaths suggesting a tuberculous origin are doubtless due to other causes. Thus one classification of mortality in nurslings is "meningitis," presumably, but not necessarily, tuberculous.

If Koch's doctrine is true the mortality of breast- and hand-fed children from tuberculosis should be the same. The actual number of deaths of nurslings from tuberculosis during 1893 to 1898 was 4,091, and of these 444 occurred in breast-fed children, leaving 3,647 deaths in the bottle-fed. The ratio then between the two classes is 1,000 to 108, nearly ten times as much mortality occurring in children exposed to the action of cow's milk.

Gottstein now proceeds to compare this ratio with that which accrues in the mortality from non-tuberculous diseases under the same circumstances. Thus from acute gastric and enteric affections there were 1,000 deaths among the bottle-fed to 43 deaths in breast children. Such a preponderance of deaths has a direct dependence upon the method of feeding and should clearly be excluded from statistical calculations. Leaving out the deaths from this classification, we find that the mortality from all other diseases, including tuberculosis, stands at 1,000 deaths in the bottle-fed to 181 deaths in breast children. Hence the expectation of death from tuberculosis in the bottle-fed is not much over one-half that to be apprehended from mortality in general (6:10) if we exclude the gastro-enteric classification.

Incidentally the statistics show that very few deaths occur either from acute gastro-enteric disease or tuberculosis in children who are wet-nursed.

Gottstein admits that the above figures have but a limited value in themselves, and seeks to give them added weight. He cites the differences which obtain in the rate of increase during the past two decades between the nursling mortality and the death rate in the older periods of life, while the mortality from tuberculosis above the nursling age has apparently diminished (this reduction being attributed chiefly to general sanitation), the mortality in the nursling period has been stated to be on the increase, or in other words, infants are not profiting by the alleged salutory effects of general hygiene. The alleged increased nursling mortality might, however, it is admitted, be attributed to improved diagnosis and better registration.

Gottstein's statistics do not agree with these calculations. From tables calculated by the author it appears that if we call the total mortality in 23 large cities of Prussia 100 in 1876, the corresponding figure for 1897 is 66.5, there having been an almost uniform decline of the death rate during these 22 years. The death rate in nurslings appears to have increased from 1876 to 1881; after which it, too, has shown a decline. Thus if we represent the death rate in 1881 by 100, the figure to represent the mortality of 1897 would be 78.3. The decline is not so extensive or so uniform as in the higher ages, and compared with some of the figures before 1881 is no decline at all, but a considerable increase.

There is, however, a special improvement since 1893, including a very sudden fall between 1893 and 1894, to be discussed later. But these calculations are incomplete if we take no account of the mortality from tuberculosis in special periods of life other than the nursling age; and the author succeeds in bringing out the fact that the essential differences in mortality do not lie between the nursling period on one hand and all the superior ages on the other, but that the true line of demarcation is between the entire period of childhood and the superior age. Thus the ratio of diminution in the mortality of the first 15 years of life is 10:9; while for the second 15 years it is 10:7.

We should bear in mind the great improvement in the management of tuberculosis in children during the past two decades; the benefit here should at least offset that which adults have derived from improved sanitation.

If, now we compare the apparently irrelevant figures and facts already adduced, we can have no doubt that there is a deep-seated difference from the etiological standpoint between tuberculosis in the child and in the adult. The former is open to some source of infection, which the latter escapes. The best evidence that at least one of these sources is infected milk is a rapid decline in the nursling mortality of 1894 as compared with that of 1893. The former year was marked by the introduction of an improved milk supply (with reference to minimizing tuberculous infection); this decline has since persisted. We find no sudden slump in the adult figures between 1893-1894.

Gottstein's statistics were collected before Koch promulgated his doctrine of dualism, and are given simply for what they are worth. In the ordinary course of events, he would have published them as documentary evidence of the perniciousness to nurslings of milk from tuberculous cows.

ON THE WARFARE AGAINST TUBERCULOSIS IN DENMARK DURING 1901.

Saugman (*Tuberculosis*, Vol. I, No. 1.) states that the past year has been of great significance in the crusade against tuberculosis in Denmark. Public aid was refused in order to stimulate private endeavor, with the result that a National League was founded with a membership of 20,000 patrons.

The Government appointed a commission to support this private movement, with the President of the National League as its head.

Up to this period there were but two hospitals for tuberculosis in existence in this country. One, for scrofulous children, at Refsnaes, dated back for 25 years, while the other, a modern institution for the care of phthisis was already filled to overflowing. This was the Vejlefjord Sanatorium, a pay institution of which Dr. Saugman is the head. The results obtained therein were so encouraging that in November, 1901, a large popular institution was established in the city of Copenhagen, the Boserup Sanatorium with 126 beds. The summer of 1902 will witness the establishment of an institution for 70 scrofulous children at Jutland. Other establishments are planned by the National League for Silkeborg (110 beds), Häsler (24 beds), and Aalborg (60 beds). Other features in the Danish warfare against tuberculosis include the well-known Finsen light institute at Copenhagen for the

treatment of lupus vulgaris, and Professor Bang's vigorous crusade against tuberculosis in cattle.

There has been a great increase in the number of publications upon tuberculosis, while interesting discussions upon the later subject have been held in the medical societies. Circulars for popular instruction are in press and will be distributed to householders.

ON THE WARFARE AGAINST TUBERCULOSIS IN ITALY.

Gatti (*Tuberculosis*, Vol. I, No. 1.) thinks that the results of this crusade while not remarkable are at least gratifying. The league originally organized for this warfare is constantly branching out with subcommittees throughout Italy. Popular publications inform the people as to the necessary prophylactic requirements. At Rome an isolation-hospital has been planned for the reception of the consumptives who gravitate naturally to the various city hospitals. A section for phthisical females is under consideration at Milan. The original summer resorts for scrofulous children at the seaside are destined to form nuclei for institutions of wider scope.

In regard to ordinary modern sanatoria for adult consumptives the Alps are being utilized in as many as four localities. City institutions, however, are not neglected. Milan is to have a sanatorium of 100 beds. Other cities which will benefit in the same manner are, Turin, Verona, Reggio, Novari, etc. The original *Caisses d'Epargne*, when these existed, are to be enlarged for the purpose.

Italy, however, is totally deficient in the German idea of insurance against invalidism in combination with tuberculosis, but this matter is being agitated by the author and others.

PROPHYLAXIS OF PULMONARY TUBERCULOSIS.

In the great *Handbuch der Prophylaxe*, edited by Nobeling and Jankau, and published at Munich in 1901, the subject of pulmonary tuberculosis is ably considered by Rosen, of Berlin, who expresses himself as follows:—The prophylaxis of tuberculosis demands an individualized elaboration by reason of the very great prevalence of this affection, together with its high mortality. The origin of consumption by contagion is not yet conceded by all, for some continue to regard this affection in the light of a dyscrasia. But not only the majority of physicians, but the intuitions of the laity as well, have placed this disease

among the communicable maladies. From this point of view the sputum is all important for prophylaxis. No one thinks seriously of the possibility of contamination from other excreta, such as urine and faeces. We must bear in mind that the expectoration of consumptives is not necessarily virulent, and it is undoubtedly true that the greater amount of this substance can no longer contaminate. On the other hand, it is impossible to distinguish off-hand between infectious and non-virulent sputum, so that we are obliged in every case to disinfect the latter. The fact that the mortality from phthisis has been reduced in Germany by one-third since 1889 is attributed chiefly to the efforts of the profession and public in this direction. Precautions of this sort are carried out to best advantage in hospitals and sanatoria. In private life patients shrink from the notoriety which is inseparable from the parade of a Dettweiler sputum-vessel. It is much to be desired that all individuals who must spit—whether bronchitics, asthmatics or other sufferers from cough with expectoration—should adopt the custom of caring for the sputum in some rational manner; for then the consumptive would be willing to conform to the general usage. The subject of "droplet infection," of the air by coughing, speaking, etc., must also be borne in mind in this connection and proper precautions taken, although the demonstration of contamination by this means is not yet forthcoming.

The entire prophylaxis of the propagation of the disease—whether spread by sputum or spray—could be covered by isolating all individuals in the later stages of phthisis. This desideratum will doubtless be secured in the course of time.

An entirely different aspect of the subject of the prevention of phthisis is that which relates to the acquisition of scrofula in infancy and childhood. As this element of tuberculosis appears to be largely a filth disease, due to infection from dirty floors, sidewalks, etc.; and as this infecton is rendered possible by abrasions of the skin and similar lesions, much good may be accomplished by requesting parents, nurses, etc., to cleanse the faces, hands and nails of their charges at frequent intervals. The floors should often be mopped and even the playthings of the children should be disinfected. The contamination in these cases may proceed from infected dust which reaches the room and settles; but it may come even more directly if some member of the family is consumptive, through the presence of sputum upon the floor.

Care should be taken not to alarm the laity by the exaggeration of the possibility of infection. We should teach that the mere proximity

and the breath of a consumptive are surely not infectious. The subject of prophylaxis should be reduced as far as possible to terms of ordinary hygiene and cleanliness. One should not drink after a tuberculous subject of course, but neither should one drink from the same cup with any individual whatever, without some attempt at self-protection from possible disease. In apartments inhabited by consumptives, good ventilation must prevail, and care must be taken to avoid raising a dust while caring for the rooms, but such precautions simply belong to general hygiene and not especially to the prophylaxis of phthisis.

So after the death of a consumptive the walls, floors and furnishings should be carefully cleansed, but these precautions are simply a part of good housekeeping, and are carried out once at least a year without special regard to past sickness. Obligatory disinfection by health-authorities has not yet become a fact after the death or departure of a consumptive from his abode, although there has been agitation in this direction.

The possibility of contamination through meat and dairy products has been fully recognized and acted upon in many countries. The alleged presence of the tubercle bacillus in butter has recently been explained upon the score of mistaken identity, so that at present butter and cheese need not be feared as vehicles of infection. As for milk, it is well to pasteurize it in all doubtful cases.

Another highly important aspect of the prophylaxis of tuberculosis takes cognizance of the possibility that apparently insignificant glandular swellings which date from childhood may contain caseous foci and virulent tubercle bacilli which are a menace to the bearer, threatening him as they do with haematogenous infection of the lungs in early adult life. If this point of view is correct all such glands must be removed when accessible to the knife. Prophylaxis of this should also be made to include strumous bone and joint disease.

Summing up the teachings of recent specialists in various branches, it appears to be the consensus of belief that all possible "external foci" of tuberculous disease should be extirpated forthwith, whether such foci are tonsils, adenoids, diseased petrous bone, enlarged lymph-nodes, etc.

There are other cases in which the patient is not menaced by the possibility of latent scrofulo-tuberculous lesions such as have just been enumerated, and in which the threat of phthisis comes purely from anatomo-physiological substratum. Such a disposition may be betrayed by a history of heredity, by the presence of general debility, by the so-called phthisical habitus (paralytic thorax, long neck, prominent

scapulae, etc.). With this group should be associated certain individuals who have acquired their predisposition to tuberculosis as a sequel to measles, whooping cough, diabetes and possibly other affections. These diseases often appear to render the bearer a good culture-medium for the germs of tubercle, just as does the constitutional peculiarity known as the phthisical habitus, which has just been enumerated. The disposition to the disease which comes from occupations, which necessitate the inhalation of dust should be added to the preceding.

All individuals thus disposed to tuberculosis—whether by latent tuberculous foci, phthisical habitus, certain diseases or certain occupations—should carry out the same general principles of phrophylaxis. Exposure, accidents, overwork, painful mental emotions, overindulgence in venery and stimulants should be avoided. In addition to ordinary personal hygiene, the subject should practice respiratory gymnastics, and should seek to harden himself by cool baths.

When a pallid, emaciated youth or maiden with paralytic thorax, and other stigmata of potential phthisis appears before the medical man, nothing is so ill advised as to state, after negative physical examination, that the patient is free from disease, that the parents should not worry, etc. All such individuals had best be regarded as acually diseased, and they should be placed at once under a suitable hygienic regimen. In no class of cases is ordinary hygiene as thoroughly indicated. The public views the matter from this standpoint and is ready to coöperate.

Naturally if these suspicious individuals present some actual evidence of incipient phthisis the physician's course is a little plainer, for probability becomes akin to proof. The medical man should therefore familiarize himself with all the signs of beginning tuberculosis of the lungs, some one or more of which may decide a doubtful case. The following are suspicious symptoms:—Loss of appetite, obstinate disturbances of digestion, a feeling of fullness after very limited ingestion of food, and generally speaking, the picture of nervous dyspepsia; disturbances of the circulation, such as tachycardia, palpitation, etc., to which may be added a general indolence and disinclination to exertion.

In all doubtful cases tuberculin should be employed—1 mg. of the original preparation. If no reaction appears after 16 hours or thereabouts, the dose should be increased to 3 mg. and later, if necessary, to 6 mg. Failure of reaction under this dosage should clear the patient of any suspicion of tuberculosis.

Marriage should be absolutely prohibited if one of the bethrothed has been ill for a long time. In recent instances the question of the advisability of marriage must be decided after weighing all the factors in the case.

[While we are in sympathy with the author's views as to prophylaxis in general, we must take exception to the statement that "the entire prophylaxis of the propagation of the disease could be covered by isolating all individuals in the latter stages of phthisis." This is indeed too broad an assertion and it must not be forgotten that tubercle bacilli may be present in the expectoration in the very earliest stages of phthisis, i. e. just as soon as softening and liquefaction of a caseous focus, of however small extent, with outward discharge, occurs.

We know that destructive processes of limited extent may be present while the patient's general condition is still such that he is quite able to come and go and to mingle socially with others. The danger to the community of propagation of the disease must, therefore, be far greater from such individuals than from those in whom the disease is so far advanced that their exhaustion and more severe illness would naturally condition a more restricted environment. In other words, a wandering source of infection endangers a greater number of persons than a stationary one.

Although the removal of scrofulous glands before they become caseous would, in theory, appear to be an effective prophylactic measure, experience in practice has shown that it does not suffice to check the progress of the disease. We know that in tuberculous glandular affections the glands become involved successively and although we may excise those which macroscopically appear diseased, it is well-nigh impossible to desect out every microscopic focus of infection.

Again all enlarged lymphatic nodes are not tuberculous and in this connection we must not forget that the cervical lymphatics are liable to become involved from various infections of the mouth, nose and throat. To render a surgical method of prevention, thorough, all such glands would also require removal unless we depend upon tuberculin to determine whether or not the trouble is of a tuberculous nature.

Further, in cervical tuberculous adenitis at no given time, when the glands present clinical evidence of disease, can it be known how far the infection has already been carried along the lymphatic course from the cervical to the mediastinal glands. Therefore, operative interference would often prove too late to prevent secondary involvement of the lungs even were it possible to completely eradicate every microscopic tubercle from the cervical lymphatic structures.—Editor.]

INFANTILE MORTALITY FROM TUBERCULOUS MENINGITIS AND TABES MESENTERICA.

Armstrong (*British Medical Journal*, April 26, 1902.) attempted to verify the statement often found in text-books, that tuberculous meningitis is rare during the first year of life. He consulted the latest returns of the Registrar-General and found that in England and Wales during 1898 and 1899, 13,130 deaths had occurred from this disease in all periods of life, and that of this number, 3,805 were in the first year of life. In other words, nearly 30 per cent. of this disease appears to occur in the nursling.

During the same two years there were 12,651 deaths in England and Wales from tabes mesenterica, and of this number no less than 6,473 or above one-half occurred during the first year of life.

The author then investigated the post-mortem records of the Liverpool Infirmary for children which extend over 17 years. About 1,000 children monthly is the attendance at this institution. Records were found of autopsies upon 70 infants in the first year of life, but of this number not a single individual had died of tuberculous meningitis. Of 85 cases in which the latter condition was found at death, there was not a single case in the first year of life and but 10 in the second. In Guy's Hospital the records of 40 years show but three cases of tuberculous meningitis in the first year of life.

In the Liverpool Infirmary but a single case of tabes mesenterica in the first year was found in the autopsy records.

The upshot of the author's experience is that there is some fallacy concerning the alleged enormous death rate from these affections as found in the Registrar-General's Reports. This is probably as follows:—The meningitis from which these babies undoubtedly die in large numbers is not tuberculous. Of the 70 autopsies on nurslings already mentioned, a number revealed non-tuberculous meningitis which

may be cerebro-spinal, purulent, syphilitic, basilar form of Barlow, etc. or some of these cases set down as examples of tuberculous meningitis, may not have been meningitis at all.

In tabes mesenterica the conditions are still more vague. Naturally many cases of death by wasting are erroneusly set down as due to mesenteric tuberculosis.

The prime object of the author's study is probably to show that the figures of the Registrar-General are not available for proving that cow's milk causes a heavy mortality from tuberculosis among nurslings.

PULMONARY PHTHISIS IN NURSLINGS.

Qurin (*Münch. Med. Wochensch.*, Feb. 11, 1902.) states that there is a sort of age limit in childhood in respect to the evidences of phthisis. After the age of 5 or 6, the latter disease begins to take on characteristics like those of adult life. Before that period, however, the symptomatology is more or less equivocal. If pulmonary lesions occur during these earlier years, they are usually secondary to tuberculosis of the bronchial lymph-nodes. The resulting lung disease seldom affects the apex, which is remote from the affected glands. Any portion of the lung may be affected which is in relation with the latter, the hilum being the usual locality to suffer. Implication of the lung occurs in these cases from rupture of the suppurating nodes.

But this is not the sole method by which the lungs of the infant may be attacked. The broncho-pneumonias which complicate measles and whooping cough may pave the way for tuberculosis. Naturally the apex is spared in this type of infection. A radical distinction then, between infantile and post-infantile phthisis is the different rôle of the pulmonary apex.

We know less about tubercle in yearlings than in any other age. A study of the disease in the early months reveals some surprises. In spite of the sweeping generalizations that the apex is not involved in the infant, exceptions must now and then occur. The author relates the history of a baby 5 months old which presented a great cavity in its right apex. Such cases are excessively rare; a parallel instance is cited from literature, in a child only 12 days old (Demme). No other cases are mentioned.

In regard to the diagnosis of these infantile cases, there is little upon which to place dependence. The existence of a cachexia is evident; cough may be absent; râles are present, but without evidence of

consolidation; febrile movement may fail entirely. This is the clinical picture than which nothing could be more vague. Personal history can cut little figure in such young children. Unless the bacillus can be found no diagnosis can be made, only a presumption. But these infants cannot expectorate, hence the sputum must be obtained artificially. Epstein aspirates the pharynx with a catheter. The author prefers a swab applied to the base of the tongue directly after the act of coughing and before the sputum can be swallowed. He sometimes uses for this purpose his forefinger enveloped in linen.

IS THE SLIGHT RISE OF TEMPERATURE EXPERIENCED BY CONSUMPTIVES AFTER SLIGHT BODILY EXERTION A TRUE FEVER?

Ott (*Berl. Klin. Wochenschr.*, Feb. 10, 1902.) refers to Penzoldt's original announcement that the temperature of afebrile tuberculous subjects could be seen to rise after moderate exertion, such as an hour's walk. The rise in such cases amounted to 38° C. and upwards. This declaration of Penzoldt was readily corroborated and Ott obtained positive results in nearly all of a series of 100 cases.

Recently Schneider, a pupil of Weicker, has called the truth of this law into question. In patients really afebrile he found no rise of temperature after exertion. On the contrary he sometimes found a fall under these circumstances.

Schneider's work, however, has proven nothing. He took his temperatures in the mouth instead of the rectum as was Penzoldt's method. This, with the report of falling temperature in certain cases, (something contrary to physiological principles) would appear to invalidate his method entirely. Besides, Bluhm has shown that the mouth temperature depends upon that of the surrounding media, so that it is inapplicable for use out of doors.

Ott has recently tested this point by taking both mouth and rectal temperatures in the same subject both before and after a walk. Before the exercise the two thermometers differed by but one or two-tenths of a degree. After the exertion, Penzoldt's law was almost unanimously confirmed by the rectal thermometer, while the other instrument showed but a very slight rise and, as Schneider found, a fall in some cases. Penzoldt's discovery may thus be regarded as settled beyond doubt. Next arises the question of its rationale.

We cannot prove that the rise of temperature is a bona fide fever. We know that a warm bath—especially a vapor bath— will produce an analogous result.

Bodily exercise produces the same kind of "heat stagnation" as does the direct application of heat. We know further that the heat regulating centre acts in the tuberculous in a defective manner. Penzoldt found the phenomenon also present in the corpulent and anaemic. The usual rationale of the rise in the phthisical is concerned with the increased absorption of the toxins of the disease from infected foci, as a result of exercise.

We know from the researches of various observers that the injection of albumoses produces fever; and vice versa, 90 per cent. of all febrile cases have albumose in the urine. On the other hand after simple elevation of temperature following a warm bath, albumosuria never occurs; so that if the urine of the experiment-subject, containing no albumose before the walk, continues free from this substance after the physical exertion, we are justified in stating that the rise of temperature is not febrile in character.

Ott therefore tested a series of these cases for albumosuria after the usual walk. In about 36 per cent. he did find albumose in the urine; and in about the same number the test gave a doubtful result. Conceding them to be positive, the conclusion is that in a considerable majority of cases, the temperature rise was febrile in character.

We therefore learn the danger of exercise in these patients, and the importance of the rest cure. Not that the patient must remain in bed all day, for he must have a little exercise. He must avoid an excess which for him means enough to produce the febrile reaction.

ON A PECULIAR ODOR OF THE EXPIRED AIR AT THE BEGINNING OF PHTHISIS.

Rosenbach refers (*Münch. Med. Wochen.*, 1902, No. 4.) to an earlier paper on this subject, in which he described a peculiar odor considered by him as an evidence of the disposition to consumption. Looking back, he can see that this peculiar breath must have a bad prognostic significance, for the possessors of it succumbed to the disease in a strikingly unfavorable form.

It is singular that the specific odor which accompanies these cases has no connection with the presence of pronounced destructive changes in the lungs. It was not present in the case of cavities, or of very extensive areas of infiltration. Even when the sputum was very abundant this smell was hardly ever in evidence. All the usual causes of bad breath were excluded in these individuals, so that the odor must have

originated at least as low as the bronchi. Its presence can be accounted for only on the supposition that some decomposition takes place which bears a relationship with the predisposition to the disease.

In a series of cases this breath first awakened in the author a suspicion of incipient tuberculosis and led him to investigate the lungs with great care, with the result that the presence of the disease was detected.

In any case of *fetor ex ore* in which no apparent cause is present, such as carious teeth, the possibility of incipient tuberculosis should be thought of. If bad teeth, ozaena, and the like are present, the author suggests that the upper passages be treated with some deodorizer. If after such treatment the odor persists it doubtless must come from the lower passages. Very many of the author's cases had poor teeth. The odor which they emitted was in any case somewhat different from the other smell, so that during expiration the latter could always be made out.

Poor teeth are very common in consumptives and are perhaps a part of the condition which invites the disease.

In this connection it should be emphasized that the hygiene of the mouth should play a great part in the prophylaxis of phthisis, for most of the destructive changes of that disease come from the ordinary pyogenic bacteria, which may flourish in neglected mouths.

[In regard to Rosenbach's recognition of a peculiar odor of the breath which appeals to him not only as an evidence of a disposition to consumption but also as of unfavorable prognostic import, it would seem to us that the author must be endowed with an olfactory apparatus of such a highly educated and sensitive nature as his professional contemporaries are so unfortunate as not to possess.—Editor.]

REST AND MOTION IN PHTHISIO-THERAPY.

Naegelsbach (*Berl. Klin. Wochenschrift*, Feb. 24, 1902.) recalls the practice of Brehmer of ordering all patients who were not bedridden to indulge systematically in walking. He no longer esteemed the reclining chair, and simply strove to guard his cases from tiring themselves out. Dettweiler originated the rest cure in the open air, and at first, as he admitted, may have been over-enthusiastic as to its virtues. Others have carried the rest cure to extremes, even keeping their cases recumbent for months. Bernheim states that it "economizes expenses and augments receipts;" and that ordinary overwork is nothing but an

auto-intoxication, the system being clogged with waste products. Naumann, on the contrary, calls attention to the fact that people who abandon vigorous life often fall a prey to the disease by reason of their diminished activities. "If rest in the open air cures consumption, it is the air and not the rest which is efficacious." Weber states that patients who have considerable temperature at night may still benefit by short walks in the morning when they are apyretic. Freudenthal would substitute an exercise cure for a rest cure.

Much may be said about the relative indications for sleep and rest in so mighty and proteus-like a disease as phthisis. Three separate elements must determine which is the more rational in a given case, viz. the patient's temperature, his type of disease, and his constitution.

If the temperature begins to rise, and especially if it is a high temperature, rest is undoubtedly indicated. The custom of placing an individual with very slightly elevated temperature in bed is not sanctioned by the author, who would have such a patient simply lie down in the open air. Individuals without any fever may exhibit subnormal temperature in the morning and must not be regarded as eligible for exercise as they undoubtedly belong in bed.

A patient who has been in bed for fever may be transferred to a couch on a balcony, and if his temperature does not go up, he may be allowed to remain there.

Schröder states that if a patient simply has fever and nothing else —no chills, sweats, prostration, increase of cough, etc., he may remain recumbent in the air.

Other conditions which allow him the same privilege are absence of recent inflammatory alterations in the lungs, and maintenance of his weight. The act of rising should not send up his temperature.

The author cannot follow Weber in allowing patients with fever of intermittent type to exercise during the afebrile period.

Some transitory fever in chronic phthisis is insignificant of any new mischief and is probably nothing more than a mild resorption fever connected with some obsolescent lesion.

The possibility of hemoptysis necessarily comes into play in connection with the alternative of rest and exercise. For persistent bleeding, the patient must keep strictly in bed.

Driver, however, distinguishes between active and passive haemorrhage and claims that exercise is beneficial in the latter form, and the author agrees that he has seen the haemorrhage cease in these cases after the patients rose and moved about. The diagnosis between active

and passive haemorrhage can be made by experts only. Hemoptysis often follows exercise; the possibility of the existence of a latent pleurisy must also be borne in mind in choosing between exercise and rest.

Aside from the conditions already enumerated certain individuals will benefit by recumbency in the open air, to-wit, all who are anaemic, chlorotic and neurasthenic.

That this mode of dealing with patients is able to slow and strengthen the activity of the heart is a well attested fact.

In walking, the patient must always rest before he is fatigued; and if he perspires very readily must beware of chills. If the ground is uneven he must go up hill when fresh that he may return down hill. A walk about 8:30 a. m., after breakfast, will stimulate the circulation of the anaemic consumptive; a second at 1 or 1:30 p. m., before dinner, will rouse the appetite. A third may be taken at about the hour when the digestion of the dinner is finished. The length or duration of the walks varies greatly. For a patient who has just thrown off his fever it should not exceed 15 minutes. Those who have become strong may walk three hours daily. We have patients who walk in the roads all day taking a luncheon with them, and who return at 11 p. m. to resume their rest cure. Individuals who are thin and unable to put on flesh walk but little. A rule of the author's sanatorium is that all patients should rest at least 20 or 30 minutes before the hearty meals. Immediately after the exercise the appetite does not assert itself.

Hill climbing will enable patients with bronchiectasis to expectorate more freely. In these cases we actually see fever disappear under exercise, evidently because the cavities have been emptied of secretions which had been responsible for resorption-fever. In old phthisical cases, when contraindications are absent, exercise will improve the weak and irregular heart action and improve the bronchitis.

FORCED FEEDING IN CONSUMPTIVES AND IN NORMAL INDIVIDUALS.

Bardswell, Goodbody and Chapman deal with this subject in one of the reports of the Scientific Grants Committee of the British Medical Association (*British Medical Journal*, February 22, 1902). The researches were made in part in the Brompton Hospital.

In case 1, which may serve as an example, the appetite and digestion were good and there was only a degree or so of fever, although both lungs were implicated and one contained a cavity. The patient weighed

120; previous maximum weight, 142. His intitial ration was milk, 3 pt.; bacon 1oz.; butter 1 oz.; bread 8 oz.; sugar 1 oz.; vegetables 4 oz.; milk-pudding 5 oz.—equivilant to 120 g. proteid, 120 g. fat and 300 g. carbohydrate. Upon this diet there was practically nitrogenous equilibrium, as but 0.32 g. nitrogen was retained. The absorption of nitrogen was 91 per cent. and of fat 94 1-2 per cent. The original ration was gradually increased until it was about double in proteid and fat and one-fourth more in carbohydrates. Under this increase a large amount of nitrogen was retained, while absorption of nitrogen rose to 97 per cent. In the last week (the experiment lasted a month) retention and absorption fell off, and anorexia and dyspepsia appeared. The diet of the second week gave the most satisfactory results, and the progressive increase of the ration was followed by deranged metabolism and irritation of the alimentary canal.

The general conclusion drawn from all the experiments is that indiscriminate stuffing of the tuberculous must give way to systematic diet based upon activity and extent of disease, amount below normal weight, digestive capacity and preference of patient.

The onset of dyspepsia nearly always coincides with commencing derangement of metabolism. Despite the unfavorable symptoms produced, forced feeding certainly continues to augment the weight; there is no doubt that a certain amount of increase in the ordinary ration is well tolerated.

The effects of forced feeding upon the normal individual comprise increase in the amount of nitrogen excreted, no reduction in nitrogen absorption, diminished absorption of fat, and a rapid and large gain in weight, associated, however, with impairment of the general health, the symptoms including anorexia, nausea, dyspepsia, drowiness, abdominal discomfort and diarrhoea. These results differ from those obtained in the earlier weeks of forced feeding in consumptives, but agree closely with the conditions observed when the latter have regained much of their lost weight.

TREATMENT OF HEMOPTYSIS AT BREHMER'S SANITARIUM WITH THE SUBCUTANEOUS INJECTION OF GELATINE.

Thieme (*Münch. Med. Wochenschrift*, 1902, No. 5.) having seen the reports of other phthisiologists on this comparatively new resource, publishes in the present paper a very brief history of twelve cases. He made the injections exclusively in the thigh. The great pain mentioned in some reports was not noted, and the author thinks it due to

some way of preparing or using the solution. He himself used 2 per cent. gelatine to which soda was added. The swelling beneath the skin was strongly compressed with the thumb and the surface of injection dressed with iodoform gauze which had been saturated with acetate of aluminum.

In two cases in which the injection contained no soda and the manipulation of the swelling was omitted extensive gangrene of the skin developed. Tetanus, which has followed the injection of gelatine, caused no trouble in the author's series. Fever was present in nearly every case, as in the experience of other reporters. Several of the patients had very high temperatures, while the duration of the pyrexia was one or two weeks. The amount of fluid injected was 100 c. c.

In regard to the results obtained they were decidedly good. In a number of cases the hemoptysis appears to have been arrested promptly. Only one absolute failure is noted. Occasionally the sputum remained slightly bloody, or a recurrence of hemoptysis was noted after some days.

Thieme concludes that despite the drawbacks of the remedy its use is indicated in desperate cases where all other measures have been exhausted. He proposes to use it in all such cases and publish his results in due time.

ON THE GENESIS OF VAGINAL TUBERCULOSIS.

Springer (*Zeitschrift f. Heilkunde*, 1902, No. 1.) has investigated this subject in the Institute of Pathological Anatomy at Prague. During the period 1887-1899 some 12 cases of this localization of tuberculosis had come under observation.

Theoretically vaginal infection may occur in the following ways:—From some other portion of the genital tract (uterus, tubes); from the urinary system through contamination with urine (by the urethra or a vesico-vaginal fistula); from the intestine (through the anus or a faecal fistula); from the peritoneum of Douglas' pouch in tuberculous peritonitis; from lupus of the vulvo-vaginal region. In addition we have infection by the blood-route and primary tuberculosis of the vagina from direct implantation of the germs from the outer world.

These two last named varieties might well be confounded; for in a case of supposed primary infection of the vagina it is impossible to prove that some small obsolescent focus in the lung may not have antedated the genital lesion.

The only case in literature known to the author as an indubitable example of primary tuberculosis of the vagina was reported by Friedlander. It occurred in a woman of 30 who had died of cerebral apoplexy. She presented a tuberculous ulcer about the external os and no other ascertainable focus of the disease.

The 12 cases of the author represent very few types of infection. Nine of them were examples of secondary infection from the uterus or tubes. Two others were cases of general miliary tuberculosis with incidental deposition of a few tubercles in the vagina. The remaining case was simply a recto-vaginal tuberculous fistula.

TUBERCULOSIS OF THE THORACIC WALLS AND DIAPHRAGM.

In one of his Lumleian Lectures upon thoracic phthisis (*Lancet*, April 5, 1902), Professor F. T. Roberts speaks of the infrequency with which mention is made of tuberculous lesions of the thoracic parietes. Nevertheless, they are of great clinical importance. Beginning with the extreme superficies, no value is to be attached to chloasma tubescentium or myoidema as specific evidence of phthisis. The alleged hypertrophy of the breasts as described in some quarters has never been seen by the author. It is said to be due to a low form of chronic mammitis. The phenomena recognized by the author are grouped as follows:

1. Wasting of the superficial tissues and muscles—including the intercostals—is of course self-evidently present.

2. Abnormal rigidity of the bony and cartilaginous walls may reach such a high degree that they become practically immovable. When occurring in an elderly person this condition is physiological and does not possess much significance; but it is otherwise with the young, and the author appears to believe in a definite relationship between this condition and chronic phthisis.

3. The shape of the chest—so-called "phthinoid" or alar formation—with resulting change of capacity is evidence of intrathoracic trouble, and the various lesions of the disease may produce a high degree of outward deformity. This type of change is most commonly seen in young and delicate subjects, but no one who contracts phthisis is exempt.

4. Phthisis sometimes develops in a chest previously deformed and especially in connection with Pott's disease.

5. The chest walls may be actually involved in the tuberculous process itself, which may affect the bones, cartilages, lymphnodes of the thoracic region, etc. Finally in very florid acute phthisis the disease

may actually extend from the lungs through the wall of the thorax, as has been recently seen by the author himself.

6. Subcutaneous emphysema may occur as an extension of mediastinal emphysema, itself due to rupture of a cavity into the cellular tissues.

7. Finally the diaphragm may be affected as a result of intrathoracic phthisis.

BOOK REVIEWS.

HEMMETER. DISEASES OF THE INTESTINES. Their Special Pathology, Diagnosis, and Treatment. With Sections on Anatomy and Physiology, Microscopic and Chemic Examination of the Intestinal Contents, Secretion, Feces, and Urine; Intestinal Bacteria and Parasites; Surgery of the Intestines; Dietetics; Diseases of the Rectum, etc. By John C. Hemmeter, M. D., Philos. D., Professor in the Medical Department of the University of Maryland; Consultant to the University Hospital and Director of the Clinical Laboratory; Author of a treatise on "Diseases of the Stomach," etc. In Two Volumes. VOLUME II—Appendicitis, Tuberculosis, Syphilis, Actinomycosis of Intestine, the Occlusions, Contusions, Rupture, Enterorrhagia, Intestinal Surgery, Atrophy, Abnormalities of Form and Position, Thrombosis, Embolism, Amloidosis, Neuroses of the Intestines, Intestinal Parasites, Diseases of Rectum. With plates and many other illustrations. Octavo, 675 pages. Published by P. Blakiston's Son & Co., Philadelphia, 1902. Price, Volume II, net $5. Set complete, $10.

This, the second volume, completes the author's treatise on diseases of the intestines. We reviewed Volume I., in the January number of the Journal and our gratification with the manner in which Dr. Hemmeter has treated his subject in Volume I. becomes more complete after a careful examination of Volume II.

No further comment is needed in order to interest those who have secured the first part of this important work, but we cannot but call attention to several sections in the volume now before us which evidence the careful clinical as well as the scientific observations and the logical conclusions of the author. One of these is the article on appendicitis, which cannot fail to be of the greatest interest both to the physician and to the surgeon and which may be accepted as a safe guide at all times and in all questions pertaining to the treatment of this affection. This excellent feature together with the full consideration given to the etiology, pathology and differential diagnosis of the disease render this chapter a complete monograph upon a subject which has attracted the best medical and surgical talent of the world.

Chapter III on intestinal occlusion, Chapter IV on contusions, rupture and perforation, and Chapter XII on diseases of the rectum, which deal with affections which, like appendicitis, present both a medical and a surgical aspect, not only give evidence of the closest study, but of a comparatively large personal, practical experience as well.

The peculiarly gratifying feature of Hemmeter's work is that he possesses the all important faculty of presenting his subject in an exceedingly clear and comprehensible manner to the reader, and that in all questions, particularly in diagnosis and treatment, he never leaves anything open to doubt, but describes methods of

procedure with a clearness of detail which renders the work of especial value to the general practitioner.

In Chapter II tuberculosis of the intestine is fully considered, while naturally the question of bovine tuberculosis in its relation to the disease in the human subject receives adequate attention.

The author rightly offers two important objections to the conclusion that, because primary intestinal tuberculosis is comparatively rare as exhibited post-mortem, it follows that food products from tuberculous animals are seldom responsible for infection. These objections are as follows:—

I. "In the first place, it has been known that the bacillus of human tuberculosis may pass the structures of the intestinal wall (mucosa, submucosa, muscularis) without leaving any trace of its existence there. After such passage without altering the intestinal tissue, it has been known to produce tuberculosis of the mesenteric, omental and peritoneal lymphatic structures."

II. "The positive exclusion of primary intestinal tuberculosis is a work of enormous technical difficulty, because it necessitates not only the macroscopic, but even the microscopic examination of the entire digestive tract from mouth to anus (26 to 30 feet), with its extensive mesentery, omentum, and peritoneum, and all its lymphatic tructures."

Hemmeter further states that the stomach and intestine give evidence of a miraculous immunity to tuberculous infection which he ascribes to the activity of digestive ferments, to peristalsis and also to some as yet obscure natural provisions for their disinfection. In this connection we would remark that the nasal, oral and bronchial mucous membranes, and in fact, all mucous membranes show this resistance, and that the usual absence of ulceration in the larger bronchi of patients who die of phthisis and who for months have discharged tuberculous sputum which must have passed over these mucous surfaces, seems even more striking. It would appear to us that the resistance of the mucosa of the gastro-intestinal tract to tuberculous infiltration and ulceration, differs not materially from that of other mucous membranes unless, perhaps, from that of certain parts of the larynx in which the conditions are extremely favorable for lodgement and retention of infectious matetial.

In the treatment of tuberculous conditions of the bowels, creosote has not been found useful by the author, although one would expect that it would be in the intestine that large doses of creosote would produce their best effects. The writer has also found creosote to be without influence, not only in intestinal, but in other local tuberculous ulcerations, as well, and in several instances of cutaneous tuberculosis where constant local applications were combined with internal administration of the remedy, creosote was unable to hinder the disease from spreading, and produced not the slightest curative effect.

On the other hand the author, while he offers nothing with a view of cure, has nevertheless been able to witness the cicatrization of a tuberculous ulcer of the rectum under the use of tuberculin, and says that he has no doubt that a number of cases have been cured by this substance, to which the writer could easily add a score from his own records. Curiously enough, however, Hemmeter is unwilling to recommend the systematic employment of tuberculin, because as he says, the remedy has not yet been satisfactorily tested, and also because the intestinal lesion is generally secondary and the localizations in other organs also demand attention.

We fail to appreciate the author's logic in this instance and can conceive of no better demonstration of the value of tuberculin than the actual healing of a tuberculous ulcer under the observer's eye, while numerous others have reported like results as following its use in visible tuberculous affections. As to the objection that the disease in the intestine or rectum is, as a rule, not primary and that concomitant tuberculous lesions also require attention, we would suggest that, inasmuch as we know of no other remedy which is able to cause cicatrization of tuberculous lesions, it might not be so bad an idea to employ it for the primary and associated tuberculous processes as well.

We know of no better guide than this work, together with the one on Diseases of the Stomach, for the prevention and treatment of gastro-intestinal affections, (which are of such frequent occurrence as more or less familiar complications in the course of phthisis). The work is replete with practical information in regard to dietetics which cannot fail to prove of great value in phthisio-therapy in which the issue so often largely depends upon the nutrition of the patient.

The International Medical Annual. A Year Book of Treatment and Practitioner's Index. Twentieth Year, 1902. New York, E. B. Treat & Co. $3.00.

In the introductory pages, Dr. William Murrell, of London, with reference to the open air treatment of phthisis, says that there are indications that it has seen its best days, inasmuch as it is bidding fair to come under the baneful influence of routine. In its connection with sanitaria and the short course of treatment usually afforded, he sees no chance for lasting results, but in proportion to the exaggerated hope of the patient, only bitter disappointment in the end.

Dr. H. P. Loomis, who has contributed the article on phthisis, takes a hopeful view in regard to the advance in methods of prophylaxis and thinks that the outlook has never been better than at the present time. In diagnosis he again recognizes the value of the tuberculin test, reproduces the interesting table of Anders of Philadelphia, which shows an aggregate of 1460 applications of the test with 71.89 per cent. of positive results in cases suspected to be tuberculous, to which in our opinion the test is to be restricted, there being no possible advantage in applying it when the clinical diagnosis can be made by the usual methods.

Under treatment, Harper's work in the use of urea is prominently mentioned. The latter's experiments in the laboratory of adding urea to the culture fluid, and which Harper reports in the same communication to the Lancet, have not received any comment. Harper says:—"In the laboratory I have tried twice to get the tubercle bacilli to grow in freshly prepared meat broth, adding urea from 1 to .001 per cent., at the same time inoculating a tube without urea as a control. In the control-tubes bacilli grew all right in the incubator; those with the urea added failed." During the past year the writer took occasion to investigate these claims and found that while an inhibitive influence could be obtained, it required .5 per cent., or 1 part in 200, of urea to entirely prevent the growth of the culture. While individual cultures of the germ may vary in virulence, our results would indicate that there is nothing characteristic in this inhibitory action of urea upon cultures of the tubercle bacillus; for various other salts in smaller amount are capable of exerting a like influence, and that these have no claim in the therapeutics of phthisis, is acknowledged. Clinically the preparation proved entirely negative in our hands.

In regard to the open air treatment, Loomis rightly attributes the improvement observed to its stimulating effect upon nutrition and thinks that the cases reported by Millet of Brockton, Mass., would seem to indicate that the limit had been

reached in this direction. Millet reported "that in all five cases results appear to have been marvelous. The temperature fell to normal, the cough disappeared, respiration was improved, and above all, a rapid and considerable increase of weight ensued," and all from subjecting the patients to a fortnight's exposure. We also believe that the limit has been reached and that the results were marvelous, but that the latter were rather due to a most remarkable limit of fortunate coincidence than to the therapeutic effect of such exposure.

A rather favorable report on formic aldehyde in phthisis is contributed by D. T. Choury Muthu who summarizes the effects of the inhalation of the remedy as follows:—

1. It soothes the laryngeal and bronchial mucous membranes.

2. The expectoration becomes less tenacious and in time diminishes in quantity.

3. It lessens the fever.

4. The tubercle bacilli diminish in number, and in some cases entirely disappear.

We have not been so fortunate in our application of the remedy; on the contrary we found that when inhaled in sensible quantities, even as little as ½ per cent. it caused much irritation and as a result increased the cough and fever, while in still smaller quantities its effects appeared indifferent. Inasmuch as tubercle bacilli which appear in the expectoration are derived from disintegrating caseous tissue, their increase or decrease in numbers or entire disappearance must stand in relation to its liquefaction and outward discharge. If, therefore, from the inhalation of formic aldehyde the bacilli diminished in number or disappeared, we can at best credit it with the power only of preventing liquifaction of caseous material in open cavities or of caseous ulcerations, and not at all on that account with any actual influence in the way of checking the progress of the disease itself.

An interesting report of high frequency currents is from the pen of Chrisholm Williams. Most remarkable results are claimed from their application.

Kelynack contributes a very satisfactory article on haematology. Boardman Reed reviews the literature of dyspepsia and functional stomach disorders.

Altogether this volume gives the reader everything of importance as regards progress in any department of the medical sciences, and the publishers have been peculiarly fortunate in securing a staff of editors and collaborators, the individual members of which are so eminently qualified, each for the discussion of his particular subject.

EDITORIAL.

THE OPEN AIR TREATMENT OF CONSUMPTIVES.

Not only, as Dr. William Murrell, of London, has expressed the opinion in regard to the open air treatment of consumptives, is this method "bidding fair to come under the baneful influence of routine," but there is a growing tendency to the adoption of measures in its application which are so extreme that they can not be too heartily condemned. "There is a mean in all things," but unfortunately some of the exponents of open air treatment seem still totally oblivious of the truth of this maxim. Patients who have active symptoms are being placed in open tents and especially constructed three-walled buildings (buildings with one side left open) and exposed to all conditions of weather in a way which is quite unnecessary and often harmful.

It is not our purpose to oppose out-of-door life in the treatment of phthisis. Much good is to be accomplished by the intelligent application of this method in properly selected cases, and the benefits of pure air and sunlight are self-evident. But in order to obtain pure air and sunlight it is not essential to resort to extreme measures. *Pure* air and *cold* air are not necessarily synonymous and, as every one knows, an abundant supply of pure air can be obtained in a properly ventilated, comfortably heated sleeping room. Besides, when patients are exposed to extremes of cold weather they must be kept warm artificially and this amounts to the same thing as the maintainance of a comfortable temperature in the sleeping apartment, except that in the first instance hardship and discomfort are added.

While in certain dry, salubrious climates, there is no objection to keeping patients out of doors at night, the proposition becomes a very different one in a rigorous winter climate. If we picture to ourselves a patient with active symptoms, high fever, night-sweats, etc., in an open tent, awaking in the midst of a cold winter night with, perhaps, the snow sifting in upon and about his bed and with his night-clothing damp or wet with perspiration, and if we consider that this patient is subjected to the choice either of lying in his damp garments or of incurring the exposure attendant upon rising to change them, his escape

from the occurrence of complications in the way of severe colds, bronchitis, or pneumonic inflammation about caseous or necrotic foci, would seem to be a matter of providential dispensation, rather than an evidence of good management.

It has been said that patients out of doors run a considerably lower temperature than when in doors, but presumably these observations relate to mouth temperatures. Inasmuch as the temperature of the mouth, or of the axilla, is influenced by that of the surrounding medium, the amelioration of fever, under such circumstances, is rather apparent than real. With even a normal or subnormal oral temperature that of the rectum will often be found three or four degrees higher in such patients.

Those who are making a fad of open air treatment and are resorting to extremes in its employment argue that exposure hardens the patient. This is not to be denied providing that the latter does not succumb to the hardening process. Surely such methods are not suitable in active stages of the disease. If they can have any value whatever, it can only be in the nature of prophylaxis in cases in which the trouble is latent or arrested. Even then the hardening process should not consist in methods in which the patient can not or will not persist after his discharge from treatment. People have for countless generations dwelt in houses and the social conditions of a modern civilization indicate that they will continue to do so. They will not live in tents in all sorts of climates and although the individual may have successfully been hardened by extreme exposures, a return to usual environments and mode of life will prove such means to have been worse than useless and of no avail as a protection in later years.

MISSISSIPPI VALLEY MEDICAL ASSOCIATION.

The chairman of the Committee of Arrangements for the Twenty-Eighth Annual Meeting of the Mississippi Valley Medical Association, Dr. A. H. Cordier, has announced the dates of the next meeting in Kansas City, Mo., as October 15, 16, 17, 1902.

The president, Dr. S. P. Collings, of Hot Springs, Ark., has announced the orators for the meeting, Dr. C. B. Parker, of Cleveland,

O., to deliver the address in Surgery and Dr. Hugh T. Patrick, of Chicago, the address in Medicine, selections which will meet with the approval of every physician in the Mississippi Valley.

A cordial invitation is extended every physician in the United States but especially of the Valley to attend this meeting and take part in its proceedings. Titles of papers should be sent the secretary, Dr. Henry Enos Tuley, 111 W. Kentucky St., Louisville, Ky., at as early a date as possible to obtain a favorable place on the program.

THE ALABAMA, GEORGIA AND TENNESSEE TRI-STATE MEDICAL SOCIETY.

The fourteenth annual meeting of the Tri-State Medical Society of Alabama, Georgia, and Tennessee will be held in Birmingham, Ala., Tuesday, Wednesday and Thursday, October 8, 9, and 10, 1902. The indications point to a program of unusual interest.

SUPPLEMENT TO THE JOURNAL OF TUBERCULOSIS.

In this part the whole subject of Pulmonary Tuberculosis will be covered by a continued series of articles written by Dr. Karl von Ruck to appear in the following order:

Article I.—The Cause of Tuberculosis, and The Conditions Which Predispose to its Acquirement. Article II.—The Prevention of Tuberculosis. Article III.—The Pathology and Symtomatology of Pulmonary Tuberculosis. Article IV.—The Diagnosis of Pulmonary Tuberculosis. Article V.—The Prognosis of Pulmonary Tuberculosis.—Article VI.—The Treatment of Tuberculosis, Dietetic, Hygienic and Symtomatic. Article VII.—The Climatic Treatment Article VIII.—The Specific Treatment. Article IX—Laryngeal Tuberculosis, its Diagnosis and Treatment. Article X.—Institutions for the Treatment of Pulmonary Tuberculosis.

THE SYMTOMATIC TREATMENT OF TUBERCULOSIS.

THE MEDICINAL TREATMENT OF PULMONARY TUBERCULOSIS.

[CONTINUED FROM PAGE 216.]

Personally I have no experience with inunctions of iodoform, but made a careful trial of its internal administration, some 15 or 20 years ago, at the time when Elsberg's claims for it popularized it in the treatment of tuberculous laryngitis.

The remedy was, as a rule, pushed until it produced its known constitutional effects and was thereafter continued in slightly diminished doses for several months. However, it did not produce sufficient amelioration in the symptoms or course of the disease to justify its continuance then or its resumption since. In glandular cases, nevertheless, I have seen decided influence from iodine preparations, especially from the syrup of hydriodic acid which for internal administration seems to me to be the most desirable form in which to exhibit iodine.

The most decided results which I have observed from the administration of iodine or of mercury in adults were in cases which presented either a clear history of, or warranted a suspicion of syphilis.

In the treatment of joint tuberculosis the value of injections of iodoform emulsion, (5 per cent. to 10 per cent.) into the affected joint has become a well recognized and very frequently recommended procedure. Hammerschlag[1] strongly endorses the application of this method in the treatment of tuberculous lymph-glands, particularly of those which have undergone softening or have resisted other antiscrofulous treatment. The softened gland is first punctured and the caseous

[1] *Bericht ueber den Kongress zur Bekaempfung der Tuberkulose*, Berlin, 1899.

detritus evacuated. Iodoform emulsion, not exceeding 1 c. c. in amount, is then injected and the treatment is repeated for the particular gland fortnightly. Indurated glands which have resisted other measures are injected in the same manner and in all cases strict asepsis is to be observed.

Arsenic in the treatment of pulmonary tuberculosis has not continued as popular as it was some years ago, although we occasionally meet with reports of marked increase in weight having occurred under its use.

Renaut[1] has given Fowler's solution per rectum in large doses equivalent to a grain of arsenious acid in twenty-four hours and claims that it was tolerated in these amounts for weeks and months. In three cases treated the pulmonary symptoms disappeared. To me it is not apparent why toxic symptoms were not produced if this amount were absorbed. Gauthier[2] uses arsenic in the form of cacadylate of soda, an arsenical preparation, the effect of which he asserts differs materially from that of arsenious acid. By doses of from 3-4 gr. to 1 1-2 gr. given hypodermically, the appetite and general nutrition of phthisical patients were remarkably improved. More than this, he claims to have observed the occurrence of resolution in tuberculous lesions of the lung. He states that when given by the mouth the remedy is decomposed into poisonous substances, and that it should be administered by the hypodermic method only, from which in his experience of several years no unpleasant effects have occurred.

Of other general tonics I should perhaps mention strychnine, which, however, is best reserved for cases in which it is indicated on account of muscular weakness and insufficient force of the heart. But Mays[3] sees in strychnine one of the four sovereign remedies in the treatment of phthisis and says that its special selective influence upon the nervous system is more particularly upon that part of the latter which is distributed to the pulmonary organs. It raises the tone of the respiratory nerves and aids digestion, assimilation and blood building. Mays recommends an initial dose of 1-32 gr., and gradually pushes the remedy to its physiologic effect. According to him the therapeutic effects are that: "Nervousness and sleeplessness are ameliorated, cough, expectoration and dyspnoea will diminish, vomiting improves, the appetite revives, and the patient gains in flesh; the weak

[1] *N. Y. Med. Journal*, April 9, 1898.

[2] *Journel des Practiciens*, March 17, 1900.

[3] *Pennsylvania Med. Journal*, Dec. 1900, p. 357.

and irritable heart becomes quiet and stronger and the general strength revives." It is to be remembered, however, that all this improvement is obtainable from general dietetic and hygienic management, especially from rest, which, together with proper feeding, counter-irritation over the pneumogastric nerves, and strychnine are the four measures which Dr. Mays finds so valuable in phthisis. In my own experience such improvement does not stand in relation to strychnine or to other remedies unless the conditions are peculiarly favorable; i. e. strychnine will not improve a failure of appetite, nervousness, restlessness, cough or dyspnoea when these sypmtoms are due to causes over which it can exert no control. Strychnine can not remove the causes upon which these symptoms depend in the stage of softening, suppuration, etc.; still its influence as a nerve stimulant is always desirable and often obtainable when there is a weak heart and to the extent to which the circulation is improved by its administration do we also secure more or less direct benefit to nutrition, which, however, in the active period of the disease referred to becomes but little perceptible, if at all.

Kalagua has in recent years been claimed to exert a specific curative influence upon tuberculosis, but it has not been shown to have any other effect than to stimulate the appetite and digestion, just as do other bitter tonics, the investigations of Bergey[1] of its influence on experimental tuberculosis having proved entirely negative.

As a general stimulant alcohol has still more or less numerous advocates and more recently a new claim as to its value in pulmonary tuberculosis has been advanced by Hammer[2] who asserts that it induced connective tissue formation in the lungs, just as we see it in the liver in cirrhosis of this organ due to alcohol. In regard to this claim, even if it were proven to be true, I would suggest that the benefit of increased connective tissue formation in the lung with the attending probability of acquiring at the same time alcoholic cirrhosis of the liver is a questionable one and one whch most physcians would prefer to forego.

The hypodermic injection of camphorated oil as advocated and practiced by Alexander is said by that author to be attended with more than the mere stimulating effect. In his earlier communications on this method, he recommended the camphor injections more particularly in advanced cases, claiming a tonic action upon the muscular tissues, especially of the heart, and a coinciding antipyretic effect. He also

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[1] *Univ. Med. Mag.*, Jan., 1901.

[2] *Deutsche Medizinal Zeitung*, 1901, p. 810.

found it to promote the patient's appetite in a remarkable degree. More recently Alexander recommends camphorated oil injections in the early stages also, and in a communication on the subject[1] he makes the remarkable statement that "camphor occupies the same position in the therapeutics of phthisis, as does digitalis in the valvular diseases of the heart."

I regret that my own use of camphorated oil injections has greatly disappointed my expectations, and beyond its known action as a stimulant, I have not been able to observe the expected increase in appetite and strength, nor any reduction in the fever, cough or expectoration, which he so confidently asserts as following its use. The cases in which I employed the method were by no means so seriously advanced as to preclude probable improvement which was finally attained by other means.

THE CLIMATIC TREATMENT: THE INFLUENCE OF CLIMATE IN THE TREATMENT OF PULMONARY TUBERCULOSIS.

The employment of climate in the treatment of pulmonary tuberculosis is so ancient a procedure and benefits have been so frequently observed therefrom in the history of the therapeutics of this disease, that it would be superfluous to urge the proposition that it is of value.

The manner in which climate acts in bringing about amelioration of symptoms and improvement in tuberculous patients is, however, still an open question, and until this is fully understood, there must always be difference of opinion in the choice of a particular resort for the individual patient. In years past the students of this question have naturally attached the greatest importance to that feature of a particular locality which differed most strikingly from the prevailing climatic conditions of the place in which the patient lived and acquired his disease; and they have constructed theories of therapeutic influence upon the supposed difference of physiological effects upon the respiratory, circulatory or general functions of the organism. A retrospect of climatic therapeutics shows that a great variety of climatic features were thus studied and warmly recommended with more or less plausible theories as to the mode of their favorable action. First the open country, then forest-covered localities, the sea shore, piney woods, warm localities and colder, rigorous regions, mountainous climates and sand deserts, have all been extolled by individual observers who happened to note striking improvement in the cases of patients who happened to resort to such places. The benefit of a dry climate has been particularly extolled, but

[1] *Berliner Klinische Wochenschr.*, 1898, No. 48.

here too, it was found that extremely dry localities, as well as those in which the moisture of the air was considerable, seemed to favor improvement in phthisical patients.

The physiological effects observed from diminished atmospheric pressure and the supposed discoveries of *immune zones* in elevated regions, that is to say of localities where phthisis apparently did not originate, led to the recommendation of high altitudes, the two conditions being usually associated. Closer observation showed that many of the climatic features which had previously appeared beneficial obtained in these elevated *immune* regions more often to greater degree, than at lower levels, and comparative bacteriologic examination of the air in in large, crowded cities, and at high altitudes appeared strikingly in favor of the latter. When to all these supposed advantages the peculiar effect of altitude upon the blood count was added, the advocates of high altitudes had made out their case sufficiently strongly as to seemingly close the controversy, and the climatic treatment of phthisis at any other than elevated regions was looked upon as a compromise that was only justified by peculiar exigencies in the individual case. As with other beliefs and theories concerning a subject that is of great interest to its students, questions pertaining thereto are, however, never closed until the truth has been found. This was the case in regard to the therapeutic effects obtained at high altitudes when they failed to prove satisfactory to such a degree as to meet theoretical expectations, and the question, although never closed, was reöpened.

More exact study showed that the effects of altitude upon the respiration and circulation were not uniformly beneficial; the deeper and more frequent breathing, made necessary by the rarefied air, was found to be actually an injury when the lung disease had reached a stage in which softening and excavation were in progress, causing increased lymphatic absorption and thereby greater degrees of fever and more rapid decline. The effect upon the circulation proved likewise undesirable in this class of cases as well as in those in which large areas were involved, preventing even in non-febrile cases the taking of sufficient out of door exercise, on account of local congestions and haemorrhages which were induced. This was shown to occur through obstruction in the pulmonary circulation by the tuberculous deposits and by the inflammatory, fibroid and destructive changes present, wherby the right heart became overtaxed and failed in its power to drive the blood through the diminished vascular channels to the left auricle.

[TO BE CONTINUED.]

THE

JOURNAL OF TUBERCULOSIS

VOL. IV OCTOBER, 1902 No. 4

ORIGINAL CONTRIBUTIONS.

ARE MEAT AND MILK A SOURCE OF SEED SUPPLY FOR HUMAN TUBERCULOSIS?

BY LAWRENCE F. FLICK, M. D., PHILADELPHIA.

Bovine tuberculosis can be inoculated into human beings. This has been accidentally demonstrated in at least seven instances when veterinarians inoculated themselves while making autopsies upon tuberculous carcasses.[1] Of the seven cases reported, which have come to my notice, one died of pulmonary tuberculosis two and one-half years after the inoculation. In the other six cases recovery apparently took place and in all but one the local sore healed upon excision of the nodule. In this one case a joint became involved. In the case which died two and one-half years after inoculation, there is a strong probability that the seed supply came from the animal upon which the man made the autopsy, but standing by itself and with the other six cases of recovery standing against it, such a conclusion must not be accepted too readily. There is nothing in the record of the case which would justify absolute exclusion of a human seed supply. But even admitting that the tubercle bacilli which led to a fatal termination in this case were derived from an animal by inoculation, with the six cases of recovery before us we would still have to conclude that the bovine tubercle bacillus does not find a congenial soil in human beings.

Apparently the converse of this proposition is likewise true—namely, that human tubercle bacilli do not find a congenial soil in animals. Human tuberculosis has frequently been given to animals both by inoculation and by feeding. It is the concensus of opinion of experimenters, however, that animals are more resistant to human tuberculosis than they are to animal tuberculosis. Koch, in his paper before the

[1]Repp, *American Medicine*, 1901.

British Congress on Tuberculosis, maintained that cattle are immune to human tuberculosis and fortified his position by a number of experiments and by the recorded experiments of Chauveau, Gunther, Harms and Bollinger.[2] Koch has been severely arraigned for his position on this subject, but many of his critics are unfair. Koch has not claimed that all animals are immune to tuberculosis. His experiments were made on beef cattle, goats, asses and sheep, the kind of animals from which it is usually supposed that human beings derive a seed supply for tuberculosis. All of these animals resisted human tuberculosis when human tuberculous matter was fed to them and inoculated into them. The position here taken by Koch is really supported by the experiments of other men, who, however, place a different interpretation upon the facts. Ravenel,[1] for example, who likewise read his paper and related his experiments to the British Congress on Tuberculosis, found all his animals less susceptible to human tuberculosis than to animal tuberculosis and found his horses, calves, sheep, and goats almost entirely immune to human tuberculosis. It is true that some of his cattle did develop tuberculosis, but it is probable that all of them would have recovered had he not killed them. The majority of them remained free from all symptoms of tuberculosis, and those which he fed with tuberculous matter and even some of those which he inoculated, remained free from all evidence of tuberculosis discoverable at autopsy. Practically, Koch's facts and Ravenel's facts are the same so far as they apply to the point at issue, but their interpretation of the facts are diametrically opposite. Koch concludes that because cattle are immune to human tuberculosis, human beings must be immune to cattle tuberculosis; Ravenel, on the other hand, concludes that because cattle are more susceptible to animal tuberculosis than to human tuberculosis, human beings must likewise be more susceptible to animal tuberculosis than to human tuberculosis, or in other words, because bovine tuberculosis is more pathogenic for animals than it is for human beings, it must likewise be more pathogenic for human beings than is human tuberculosis. Of the two interpretations that of Koch is undoubtedly the more rational and logical. All nature is akin and the same fundamental laws govern everywhere. If human tuberculosis, by reason of continuous growth upon a certain soil has become indigenous, it is probable that animal tuberculosis, for the same reason, has become indigenous in animals. Moreover, the authentic cases of transmission of animal tuberculosis to human beings, of which we have record, show the same benignity as

Koch, *Journal of Tuberculosis*, Vol. III, No. 4, p. 334.

[1]Ravenel, *The University of Penn. Medical Bulletin*, 1901.

the transmission of human tuberculosis to animals. And in the paucity of numbers of cases of accidental inoculation of human beings with animal tuberculosis, when we consider the number of people who are using the knife daily upon tuberculous carcasses, we have, to some extent, a parallel illustration of the immunity of human beings to animal tuberculosis, to the experimental demonstration of animal immunity to human tuberculosis by inoculation. Accidental inoculation of man with animal tuberculosis must be of frequent occurrence among butchers, meat dressers and veterinarians, and if such inoculation were followed by implantation and growth, it would certainly come to the attention of the physician or surgeon. Yet the most painstaking search for recorded cases reveals but seven.

It would appear from some experiments which have been made, that the tubercle bacillus can be changed in its pathogenicity by grafting. The law governing this variability, however, is not yet discernable. What bearing it may have on the relationship between human and animal tuberculosis cannot be determined until we know more about it. For the present we have evidence only of the increase in virulence of human tuberculosis when grafted upon animals. Ravenel[1] found that human tuberculosis which had been inoculated into pigs and recovered, had greatly increased in virulence for rabbits and guinea pigs. In this connection it would be interesting to know whether animal tuberculosis recovered from human beings has increased in virulence. So far as I know, the fact has not yet been determined by experiment. At any rate the little knowledge which we have upon the subject does not tolerate the inference that animal tuberculosis possesses greater virulence for man than for animals, but rather combats it. According to the law of reversion the increase in virulence of the tubercle bacillus by passing from man to animals would indicate that the natural habitat of the tubercle bacillus is to be found in the lower scale of the animal kingdom and not in the higher, and that the human tubercle bacillus is a product of evolution from a parent stem which is common to all the varieties of tubercle bacilli.

Bovine tuberculosis is probably less pathogenic for man than it is for animals; at least it is not more so. At the Storrs Agricultural Experiment Station, in Connecticutt,[2] feeding calves with the milk of tuberculous cows failed, in many instances, to convey the disease. Gebhard has shown by experiment that attenuation of tuberculous milk,

[1]Ravenel, supra cito.

[2]Twelfth Annual Report, 1899, p. 158.

one to fifty, makes it sterile even for inoculation of guinea pigs. Repp[3] has collected a large number of reports of inoculation experiments and feeding experiments with milk of tuberculous cows, for the purpose of demonstrating the transmission of bovine tuberculosis to human beings. He quotes twenty-three series of inoculation experiments and ten series of feeding experiments, made in different parts of the world. Some of the reports of these experiments are too indefinite to be available in the computation of per-centages of results. In eighteen of the twenty-three series of inoculation experiments and in six of the ten series of feeding experiments results can be computed. Sixteen of the inoculation experiments were made with milk from cows known to be tuberculous, and two were made with mixed milk as supplied to the market. From the sixteen series of experiments with tuberculous milk there were obtained 23.88 per cent. successful inoculations, and from the two series of experiments with market milk there were obtained .43 per cent. successful inoculations. In five of the series of experiments, including the two made with market milk, the milk was centrifugalized and the sediment used. In six of the series of experiments, milk was used from herds in which there was at least one cow with diseased udders. In one of the series of experiments in which the milk was taken from a cow with diseased udders there were 100 per cent. successful inoculations, and in another in which the milk was taken from a herd of tuberculous cows, two of which had udder involvement, there were 66.66 per cent. successful inoculations. If we remove these two series of experiments from the entire group we have 11.98 per cent. successful inoculations for the other ten series. The great variation in the results of these experiments leads one to suspect that some of them may not have been carefully performed. Stein, for example, is reported to have had 28.5 per cent. successful inoculations with the milk of cows with healthy udders, whilst Schroeder, in three series of experiments with the same kind of milk, got only .19 per cent. successful inoculations. Stein, moreover, inoculated only fourteen guinea pigs whilst Schroeder inoculated eighty-eight. The combined results of Adami, Ravenel, Russell, Delepine, Schroeder and Nocard give only 4.09 per cent. successful inoculations in four hundred and thirty-six experiments.

In the feeding experiments reported by Repp, seven out of twelve are definite enough to warrant computation of results. The per-centage of implantation for these seven series of experiments is 30.4 per cent. Here again the wide divergence of results makes one suspicious of the methods used by some of the investigators. Law, Bang and Ernst, in

[3]Repp, supra cito.

their combined experiments had 70.9 per cent. implantations, whilst Russell, Peuch and Adami had none.

The results of experimentation with tuberculous meat, as reported by Repp, are much the same as those with milk. Arloing had 30 per cent. successful inoculations with the muscle juice of tuberculous cows; Nocard had 5 per cent.; and Veyssiere and Humbert had 100 per cent. The three combined had 45 per cent. In feeding experiments Johne, Gerlach and Peuch combined had 45.2 per cent. implantations, whilst Nocard, Perroncito and Galtier had none.

The net results of all the experiments quoted by Repp are less than one implantation in four seed scatterings, and this under the most favorable conditions possible. It is fair to assume that under more natural conditions, that is, the animals taking the milk and meat as food in the way in which they ordinarily get them, there would have been no implantations. If milk and meat are practically harmless to animals which are susceptible to bovine tuberculosis, surely they cannot be a great source of danger to human beings who are insusceptible. So far as experimental proof goes it may therefore be assumed that milk and meat are not a source of seed supply for human tuberculosis.

Clinically we have no evidence at all that animal tuberculosis is transmissible to human beings through milk and meat. Many cases have been recorded in which children who had been drinking the milk of tuberculous cows developed tuberculosis, but there is nothing in the records of the cases to show that the occurrence was more than a mere coincidence. The mere absence of a tangible history of exposure to human tuberculosis in such cases is not sufficient. Tuberculosis is a very insidious slow growing disease in the beginning, hence the time of implantation may antedate the development of the noticeable symptoms so long as to have been forgotten. Moreover, the exposure may be of a character to be easily overlooked. A case in point will illustrate this. A child 9 years old was stricken down in perfect health with grippe, followed by pneumonia. The attack ran an ordinary course and in due time convalescence set in. The lung did not get well, however, and after some weeks a recrudescence set in which was of a rather chronic character. A consultation was called for and the consultant diagnosed the case one of tuberculosis. Both the family physician and the family insisted that there had been no exposure to tuberculosis, direct or indirect. The family physician had known the child from birth, having attended at the accouchment. Prior to the present attack the child had been a model of health, and the tuberculosis was of the acute miliary type. The most searching inquiry revealed no history of exposure. After three or four weeks' reflection and self-examination the mother

announced that she believed she now knew where her child had gotten the disease. While the child was sick with pneumonia the doctor had ordered a feeding cup. A messenger was sent to the drug store for a cup, but could not get one. A neighbor who happened to be present when the messenger returned, offered a cup which was accepted. This cup had been used for many months by a consumptive child and had not been disinfected. In concluding her story the mother said that she had noticed that the cup was not clean and for this reason had rinsed it carefully before using. Now had the original inquiry into the history of this case revealed the presence of a tuberculous cow from which the milk had been used it would probably have been set down as a case in which the seed supply had come from the cow.

Standing side by side with this negative evidence and supporting it, we have the most convincing clinical evidence that human tuberculosis is always derived from human sources. Prolonged intimate contact with a consumptive in the last stages of the disease undoubtedly is the most prolific cause of new implantation of the disease. For every case of tuberculosis which dies at home a number of people are subjected to prolonged intimate contact. Besides this intimate contact at home, there is prolonged intimate contact with nearly every case during the earlier stages of the disease, by a number of persons, in the workshop, the store and the office. Then again we have the prolonged intimate exposure resulting from occupation of houses and rooms which have been occupied by consumptives and the use of implements, utensils and clothing which have been used by consumptives. In all there are probably from five to six prolonged intimate exposures for every case of tuberculosis in existence. The number of implantations which grow and develop into full fledged cases of tuberculosis out of these exposures, however, is less than one new case for every old case in existence. Every case of tuberculosis in a human being, therefore, is accounted for many times over by the exposure to another case in a human being. Even if we demand a well-defined exposure to human tuberculosis for every new case, we can find it by carefully going into the history of the case. But in doing this we must bear in mind that tuberculosis is an insidious, slow growing disease and exists frequently where it is not suspected. Some people are so nearly immune to tuberculosis that they will carry it through a long lifetime without developing symptoms which attract attention. Such cases can give the disease to others without it being suspected whence the seed supply came. A case in point will illustrate this. A semi-educational institution for boys has been under my medical supervision for some years and I have been in the habit of visiting it daily during that time. There had not been the slightest

suspicion that there was a case of tuberculosis in the house when one day I accidentally discovered the disease in one of the prefects who consulted me for a cold. The man had been in the house for a year. He had a small secreting cavity from which he was expectorating bacilli-bearing matter, and upon inquiry I found that he had been spitting quite promiscuously around the place during the time that he had been there. Fearing that the disease might have gotten a foothold in the place I at once made a careful examination of every boy who showed the slightest symptoms and to my surprise I discovered two cases, one of which had already advanced to the stage of softening.

For the implantation of the tubercle bacillus, a liberal scattering of seed supply is necessary, and ordinarily this scattering must continue for a considerable period of time, because much of the seed falls on barren soil and much is destroyed by the phagocytosis of the living body. In every day life, whether it be in the animal kingdom or in the human family, successful implantation takes place through prolonged intimate contact, direct or indirect, when the seed can be gradually and continuously taken up until, at an opportune moment, some finds lodgment in the right place and in the proper condition of the system for germination, or until so much has been taken in as to overpower phagocytosis. In the animal kingdom the introduction of a tuberculous animal into a herd means implantation of the disease in the herd in the course of time, or tying up of the healthy animal in a stall which has been occupied by a tuberculous animal means implantation of the disease in a healthy animal. In the human family prolonged, intimate, social relations between the well and the sick, prolonged use of the things which have been used by the sick or occupancy of houses which have been occupied by the sick, are the ordinary modes of implantation of the disease. These facts are well established, not by artificial methods in laboratories, but by clinical evidence in every day life. There seems to have been too much stress laid upon laboratory deductions. The bacteriologist is apt to conclude that what he can accomplish in the laboratory is accomplished outside. This does not follow, however. For the purpose of applying laboratory deductions to practical life the hygienist must make full allowance for the difference in conditions.

Meat and milk are too important a food supply to permit an unfounded prejudice to arise or stand against them. They are not only an important food supply during health, but they constitute a valuable asset in the treatment of tuberculosis. For the poor there is no more economical food than milk. A poor consumptive can find in milk almost a complete armamentarium for his recovery. Four to five quarts of milk a day without other food and without medicine will sometimes

restore incipient cases to perfect health. With milk as the basis and meat, vegetables and fruit for supplementary purposes an economical diet of an ideal character can be arranged for the consumptive, such as no other combination of food can give. Much injury already has been done by the creation of unwarranted fear in the public mind about these foods. Even consumptives are afraid to use them. Of meat there is less fear than of milk, because it is customary to eat meat cooked. Meat is improved by cooking and when the public is advised to eat cooked meat no mental friction is created by such advice. But with milk it is different. Cooked milk is disagreeable to many and indigestible to some. Even heating the milk to the boiling point modifies it sufficiently in taste to make it disagreeable to many and according to some authorities makes it less digestible than when raw. Advice to boil milk is therefore not well received and frequently leads to a disuse of milk. It is of the greatest importance of course, that milk and meat, being important articles of food, should be pure and be the product of healthy animals. The government should protect the public in this regard in every way possible, and should use every legitimate means of stamping out tuberculosis among domestic animals. The work of stamping out tuberculosis among cattle should, however, be made to stand upon its own merits and not be predicated upon stamping out tuberculosis among human beings.

Probably the most pernicious effect of the spreading of false doctrines about the dependence of human tuberculosis upon animal tuberculosis for seed supply, is the interference with the introduction of proper measures for the prevention of human tuberculosis. So long as the public is permitted to remain in doubt as to the true source of seed supply for human tuberculosis, so long will it be apathetic about the introduction of proper measures for its prevention. Up to the present time very little has been done by governments for the prevention of human tuberculosis. Considerable money has been expended for the stamping out of tuberculosis among cattle and this is as it should be—indeed too little has been appropriated for this purpose; but unfortunately the impression has gotten abroad that money devoted to this purpose is at the same time accomplishing the task of stamping out human tuberculosis. Very few governments have as yet taken money from the public treasury for the establishment of sanatoria for the consumptive poor and comparatively little is as yet done by boards of health in the sterilization of houses which have been occupied by consumptives. Quite recently the mayor of one of the first cities in the land stopped the contemplated action of the board of health to register

tuberculosis, ostensibly upon the score of economy. Outside of private effort, put forth either by individuals or by societies, very little has been done in the way of public education on the contagiousness of tuberculosis and personal hygiene in regard to the disease. Why all this apathy about a matter which is of such vast importance to every human being? Is it not because the public does not yet understand the subject? For the misapprehensions which exist, the medical profession is primarily responsible and it has been led into a false position upon the subject by giving too much weight to the laboratory evidence and too little weight to the clinical evidence at its command.

LIGHT—ITS THERAPEUTIC IMPORTANCE IN TUBERCULOSIS AS FOUNDED UPON SCIENTIFIC RESEARCHES.

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[CONTINUED FROM PAGE 256.]

Experiments with red fluid media have shown that plants, under certain circumstances, have decidedly bent from it. It is a hard problem at the present state of our knowledge how to explain this as the effect of mere heat; it would appear that some property resides in the red rays which acts in opposition to the general law.

A few remarkable results must yet be noticed. Under all ordinary circumstances plants bend in a very decided manner towards the light. This is known as heliotropic phenomena. Herr Wiesner presented a monograph to the Vienna Academy in 1878, which is found in the *Anzeiger* of that academy; an idea of some of the fruits of his researches on this important subject is given in detail. In studying the *influence of light* and heliotropism, Herr Wiesner's experiments were made in the light of a gas flame which burned under a constant pressure with a uniform intensity (luminous power, 6.5 spermaceti candles). The unit for the measurement of the light intensity was the strength of this flame at the distance of one metre. It was found that in heliotropism three cardinal points of light intensity are to be distinguished, an upper limit, a lower limit, and between the two, an optimum of light intensity. Thus with decreasing intensity of light, the strength of the heliotropic effect increases to a certain point, and beyond this point decreases. The lower limit referred to coincides with the lower limit of light intensity for the stoppage of growth in length, while the upper limit does not coincide, or only occasionally coincides with the upper

limit of light intensity for the growth and length; for in the case of plants very sensitive heliotropically, it lies higher, and in less sensitive plants lower, than the upper limit for growth in length. The mode of arrangement of the experiment in gas-light did not permit of determining in all cases the limiting values of the light-intensities; thus, for example, the upper limit for the heliotropism of etiolated shoots of *Salix alba*, and of the hypocotylous portion of the stem of *Viscum album*, and the lower limit for the heliotropism of the growing stem of vetch could not be ascertained. The former lies about 400, the latter far below 0.008. The optima were found to lie between 0.11 (the growing stem of the pea) and 6.25 (etiolated shoots of *Salix alba*). Both with gas light and with natural light, it was ascertained that, beyond a certain intensity, no growth in length occurs.

He also speaks in this treatise of the relations between the refrangibility of the light rays, and the heliotropic effects. The experiments were made partly in the objective spectrum, partly in the varieties of light, gotten by sending white light through colored solutions. * * It was proved that portions of plants very sensitive heliotropically, e. g. growing stems of *Vicia sativa* undergo curvatures in all kinds of light, even in ultra-red and ultra-violet, with the exception of yellow. The maximum of the heliotropic force of light lies at the boundary between violet and ultra-violet; a second (smaller) in the ultra-red. From both maxima the power of the rays to produce heliotropism decreases gradually and to the yellow. Portions of plants little sensitive heliotropically, are no longer influenced by orange, or by red and green, or even in the case of etiolated shoots of *Salix alba* by ultra-red rays. The yellow rays quite stop the heliotropism; for example, in pure red a quicker and stronger heliotropism occurs in a light which gives yellow besides red. In another section of his experiments he gives us some important results on the joint action of positive and negative heliotropism and (positive and negative) geotropism. It is here shown *inter alia* that, in the case of plants very sensitive heliotropically, the geotropism is, at the optimum of light intensity, apparently extinguished, even in strongly geotropic organs; further, that in many organs (growing stem of the pea) the heliotropic and geotropic powers of curvature disappear simultaneously; in others, however, (stems of cress) the younger portions of the stem are more strongly heliotropic than the older; and the oldest aftergrowing portions of stem no longer show bendings in the light, but, through drawing action on one side the heliotropic overhanging point of the stem, show apparently heliotropic curvatures chiefly due to growth, which are then counteracted by negative geotropism.

The arguments go to prove that heliotropism is due to the phenomenon of unequal growth upon unequally lighted sides of an organ, which he forcibly sets forth in many experiments, and proof is offered that, for heliotropism as well as for growth in length, free oxygen is necessary.

He also furnishes proof that the conditions for heliotropism remain constantly the same during its course and coincide with the conditions for growth in length; further that heliotropism (and the same holds good for geotropism) occurs as a phenomenon of induction. It is also shown that when light induces heliotropism in an organ, a fresh heliotropic or geotropic induction meets with resistances, and can only come into action after extinction of action of the first; and that the successive impulses of light and gravity, of which each by itself is capable of producing certain effects, do not have their action added together when the effects that should be obtained separately are in the same direction, e. g., and the same side of the organ is helped in its growth in length.

LIGHT—ITS EFFECT UPON COLORED JUICES OF FLOWERS AND OTHER PHENOMENA.

The action of light on the juices of plants has been carefully studied by M. Chevreul; but as his experiments were made with reference only to their permanence as dyeing materials, and with white light as it proceeds from the sun, they afford no information as to the influence of the separate rays, but, nevertheless, they are of vast value from a therapeutic point. This subject has alone engaged the attention of Sir John Herschel and Mrs. Somerville.

I shall mention as briefly as is consistent with a correct understanding of the matter, several of the most remarkable results obtained upon vegetable juices, referring all those who may desire more detailed information to his memoir itself.[1]

In the *Philosophical Transactions* for 1844 is published an extract of a letter from Mrs. Somerville to Sir John F. W. Herschel, dated Rome, September 20, 1843, on the action of the rays of the spectrum on vegetable juices. There is so much that is curious in this communication, that I have extracted a portion to show the character of the investigations in which that lady was engaged.

"In the following experiments the solar spectrum was condensed by a lens of flint glass of 7 1-2 inches focus, maintained in the same part of the screen by keeping a pinhole, or the mark of a pencil constantly at the corner of the red rays, which were sharply defined by

[1]On the Action of the Rays of the Solar Spectrum on Vegetable Colors etc. *Philosophical Transactions*, Part II, 1842.

using blue spectacles to protect my eyes from the glare of light, and the apparatus was covered with black cloth in order to exclude extraneous light.

"Thick, white letter paper, moistened with the liquid to be examined, was exposed wet to the spectrum, as the action of the colored light was more immediate and more intense than when the surface was dry. As I had not access to the morning sun, the observations were made between noon and three in the afternoon."

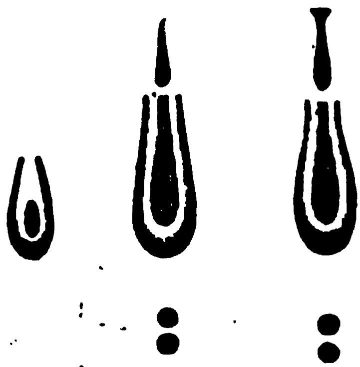
Mrs. Somerville approached very near to the discovery of the extra spectral rays of Stokes, as the following paragraph shows.

"The lavender rays came vividly into view; under a condensed spectrum, on white paper washed with a solution of sulphate of quinine in dilute sulphuric acid, they were narrow and their length by rough measurement was equal to the distance between the upper edge of the violet and the lower edge of the blue. They were very brilliant on black silk or other dark surfaces, and invariably of lavender color; and even on paper stained with turmuric, the pale yellow rays which you had observed were tipped with lavender, on being washed with the liquid though its duration was only momentary, as it vanished as the surface became dry; but they were permanent in other instances.

"The lavender rays change their color with a change of the liquid; for instance, they are lavender color on nitrate of silver discolored by light to a very pale brown, washed with a solution of sulphate of quinine in dilute sulphuric acid; whereas, on a similar surface of pale brown nitrate of silver, washed with the juice of the petals of the pale blue *Plumbago auriculata* in distilled water, to which sulphuric acid was added, they appeared of a vivid apple green, and acquired a tip of lavender color on the surface being washed with a solution of sulphate of quinine in dilute sulphuric acid of considerable strength. The effect, however, was transient. After several unsuccessful attempts to repeat this experiment next day, I at length discovered that its success depended upon the acid being strong enough to decompose the juice and give it a redish orange hue, and even then the rays are not vivid till the paper has been frequently washed with the juice and become nearly dry; and the experiment is more successful when the liquid has been kept a night. The action of the surface in changing the color of the lavender rays may be illustrated by passing the spectrum over paper coated with nitrate of silver brought to a clear yellow brown by exposure to the sun, one-half washed by the liquid in question, and the other half with a solution of sulphate of quinine in dilute sulphuric acid, and the first half of the lavender rays become vivid apple green, while on

passing to the other half, they instantly changed to an equally vivid lavender color. These rays often darken the surface throughout their whole length; sometimes they acquire a powerful bleaching action, and sometimes they have no effect, as evidently appears from the following experiments:

"The juice of fresh-gathered petals of double flowering pomegranate in alcohol afforded an example of this. Paper washed with this juice became rich crimson, and on being exposed wet to the condensed spectrum, a narrow line of deep crimson was formed at the junction of the green and yellow rays, or perhaps in the most refrangible yellow, surrounded by a whitish lozenge shaped border (a). On again washing the juice, instead of the white border, which had vanished, there was a crimson flame-shaped image, curved at the lower edge of the yellow rays, and tapering upwards to the violet; its color was darker than that of the ground, though paler than the narrow line which maintained its intensity, and although the latter increased in width, it did not become as broad as the image in question. At the upper end of the violet another little dark image was formed, apparently owing to the action of the lavender rays, having exactly their form; the orange and red rays, especially the red, had no effect, though at the distance of about half the length of the spectrum beyond the red, two distinct spots were formed of deep crimson, which I believe to be the best spots which you discovered. After some time a bleaching appearance surrounded the whole image from the red upwards, probably owing to rapid evaporation from the heat of the spectrum (b).



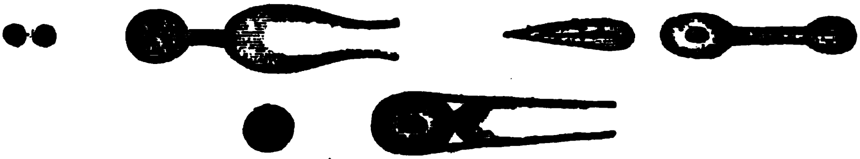
a *b* *c*

"Exterior bleaching frequently took place in the course of the experiments, permanent in some instances, while in others it vanished as the surface dried. When water was used with the juice instead of alcohol, the general character of the image was similar to that

described, except that the small figure beyond the violet was more distinct, and seemed to bear the same proportion to that formed by the rest of the spectrum which the length of the lavender rays bears to the length of the sum of the others; the bleached part round the whole was more extended and a faint crimson haze encompassed the dark spots, which were very distinct (c).

"The following are some of the cases in which the simultaneous effect was produced. For example, paper washed with the juice of the petals of *Globe amaranthus* in distilled water, on exposure to the spectrum, acquired a delicate pink tint which was soon bleached to whiteness from the upper edge of the green to the end of the lavender rays, while at the same time a perfectly circular spot of equal whiteness was seen under the red rays and a little way below them, which had the appearance of being an image of the sun. After more washing with the juice, the two bleached parts were united by a long white neck which speedily vanished, and was succeeded by a dark crimson image, whose greatest intensity of color was under the yellow rays. At some distance below the red rays two crimson spots were strongly marked, especially the uppermost, both surrounded by a paler halo.

"The juice of the petals of pale blue *Plumbago auriculata* in distilled water imparted its tint to writing paper, which after exposure to the action of diffused light acquired a pale yellowish green hue. The part under the lavender and violet rays of the spectrum, repeatedly washed with the juice assumed a pale brown color. The indigo rays seemed to have no effect, although from their lowest edge to the distance of half the length of the spectrum below the red rays, a lavender blue image was formed. Under the orange rays a minute indigo-colored spot appeared, and also a larger spot of the same color under the yellow, which were soon blended into one, forming a single oblong figure of maximum intensity, surrounded by a halo of paler indigo. An isolated disc of the same color as the halo, with two dark spots in its center, appeared at the same distance below the red rays.



"The juice of the beet-root in a strong solution of common salt, imparted a pink color to the paper, and the most refrangible rays acquired a powerful bleaching energy; the pink ground was whitened under the lavender, indigo and blue; a deep crimson spot was formed

under the yellow, with a rose-colored halo, elongated to the bleached part on one side and to the end of the orange on the other, while a hazy rose-colored disc was visible at a distance below the red. The crystallization of the salt on this figure was, in proportion to the intensity of color, most on the crimson spot and its halo, and on the colored disc, but scarcely any on the bleached portion."

The great number of instances now adduced in which we have distinct evidence of *chemical change* under the influence of the sun's rays appears sufficient to support the position, that the solar and electric arc-light rays are continually acting upon matter—it signifies little in what form it may be presented to their influence. We have distinct evidence that a sunbeam or the electric arc-light beam cannot fall upon any solid body without leaving permanent traces of its action. Throughout all these cited experimental researches the observations have shown the fact only too plainly.

The most casual observer could not fail to remark the peculiar influences of the solar agencies at different seasons of the year. In spring a fresh and lively green pervades the field and forest; this in summer assumes a darker hue and in the autumn passes gradually into a russet brown. There is no doubt that there is a marked difference in the chemical action exerted by the solar rays an hour or two before noon, or an hour or two after it. I was convinced at an early period of my experimental work of that fact, and the continued observations of some years prove that similar differences are to be detected between the solar emanations of the vernal and the autumnal periods (I have found these facts from some photographic experiments). The changes in the color of the leaves appear to be entirely dependent upon the absorption of oxygen which all the green parts of plants have the power of absorbing without intermission. This true case of chemical affinity, it would appear, goes on equally with the spring or the summer leaves; but during these periods the vital force, under the stimulus of the light, is exerted in producing the assimilation of the oxygen for the formation of the volatile oils, the resins and the acids. In the autumn this exciting power is weakened; the summer sun has brought the plant to a certain state, and it has no longer the vital energy necessary for continuing these processes. Consequently, the oxygen now acts in the same manner on the living plant as we find in experiment it acts upon the dried green leaves, when moistened and exposed to its action. They absorb gas and change color.

Sir John Herschel observes in reference to the action of light on the juices of plants: "The earlier flowers of any given species reared in

the open air, are more sensitive than those produced, even from the same plant at a later period in its flowering, and have their colors more completely discharged by light. As the end of the flowering period comes on, not only the destruction of the color by light is slower, but residual tints are left which resist obstinately." These residual tints are the same which produce the brown of the autumnal leaf; and the same agent may be traced in the production of photographs upon papers spread with expressed juices and on the changing colors of flowers and leaves.

Here we come to another most interesting physical problem which holds our attention for a brief moment. We find that the woody fibre of plants and all the carbon which is found as an elementary constituent of the resins, gums, juices, etc., of the vegetable world, is derived exclusively from the atmosphere to which it is supplied by the respiration of animals and all those processes of combustion which are continually going on. By some peculiar function these leaves of plants during every moment of their lives are absorbing carbonic acid. It has been stated that the reverse of this takes place during the hours of darkness, and that at night the leaves absorb oxygen, and exhale carbonic acid. It appears to me that this statement has been made without sufficient consideration, or the requisite experimental evidence.

"This reversal at night," says a most talented philosopher, "of what was done in the day, may, at first sight, appear at variance with the unity of the plan which we should expect to find preserved in the vegetable economy, but a more attentive examination of the process will show that the whole is in perfect harmony, and that these contrary processes are both of them necessary in order to produce the result intended."

He then, evidently feeling the difficulty of the question, proceeds to explain this harmony as follows:

"The water which is absorbed by the roots generally carries with it a certain amount of soluble animal and vegetable materials which contain carbon. This carbon is transmitted to the leaves, where, during the night, it is made to combine with the oxygen they absorb. It is thus converted into carbonic acid, which, when daylight prevails, is decomposed, the oxygen being dissipated, and the carbon retained. It is evident that the object of the whole process is to obtain carbon in that precise state of disintegration to which it is reduced at the moment of its separation from carbonic acid by the action of solar light on the green substance of the leaves; for it is in this state alone that it is available in promoting the nourishment of plants, and not in the crude condition in which it exists, when it is pumped up from the earth along

with the water which conveys it into the interior of the plant. Hence the necessity of its having to undergo this double operation of first combining with oxygen, and then being precipitated from its combination in the manner above described." These passages are selected, not with any view of reflecting upon their accomplished author, but because they afford the best expression of the views which have been generally entertained on the strength of the experiments of Saussure and Grishchow, which admit of another explanation.

It is the green parts of plants, principally the leaves and to a less extent the bark, which absorb carbonic acid. Plants grow in soils composed of divers materials, and they derive from these, by the soluble power of water which is taken up by the roots and by mechanical forces carried over every part, carbonic acid, carbonates and organic matters containing carbon.

Evaporation is continually going on, and water escapes freely from the leaves during the night, when the functions of the vegetable, like those of the animal world, are at rest. "A cotton wick," says another experimental philosopher, "enclosed in a lamp which contains a liquid saturated with carbonic acid, acts exactly in the same manner as a living plant—in the night. Water and carbonic acid are sucked up by capillary attraction, and both evaporate from the exterior part of the wick."

A plant placed in a vessel containing water impregnated with carbonic acid and carefully closed, so that no water could escape by evaporation except through the plant, was placed under the receiver of an air pump in which was put some pure potash, and a good exhaustion effected. The potash was found to have absorbed carbonic acid. The same arrangement was made, only that the water now used was distilled. Under the same circumstances in every respect, a like quantity of moisture was found to be absorbed by the caustic potash, but of course no carbonic acid. In these experiments the carbonic acid and water were mechanically drawn through the plant.

Precisely similar arrangements were placed under bell glasses filled with atmospheric air which was dried and freed from carbonic acid by exposure to potash for some time. In neither case could any diminution of the quantity of oxygen be detected, but traces of carbonic acid were found in the air in which the plant in the carbonated water was placed. These experiments were in the dark, and eudiometric examinations of this air have convinced Mr. Hunt that some oxygen is always given off.

There is no reversion of the processes which are necesary to support the life of a plant; the same functions are operated in the same way by day and by night, but differing greatly in degree. During the hours

of sunshine, the whole of the carbonic acid, absorbed by the leaves or taken up with water by the roots, is decomposed, all the functions of the plant are excited, the processes of inhalation and of exhalation are quickened, and the plant pours out to the atmosphere streams of pure oxygen, at the same time as it removes a large quantity of deleterious carbonic acid from it. In the shade, the exciting power being lessened, these operations are slower, and in the dark they are very nearly, but certainly not quite, suspended.

We have now certain knowledge. We know that all the carbon which forms the masses of the magnificent trees of the forest, and of the herbs of the fields, etc., has been supplied from the atmosphere to which it has been given by the functions of animal life and the necessities of animal existence. Man and the whole of the animal kingdom require and take from the atmosphere, its oxygen for their support. It is this which maintains the spark of life, and the product of this combustion is carbonic acid which is thrown off as the waste material and deteriorates the air. The vegetable kingdom, however, drinks this noxious air; it appropriates one of the elements of this gas, carbon, and the other, oxygen, is liberated again to perform its service to the animal world. It is not possible to conceive a more perfect, a more beautiful system of harmonious arrangement than this, making the animal and the vegetable kingdoms mutually dependent. The existence of the one ceases when the other is destroyed. If the vegetable world was swept away, animal life would soon become extinct; and if all animal existence was brought to a close, the forest would fall and the flowers of the field which now clothe the earth with gladness, perish in the utterness of a lamentable decay. It has been supposed that the vegetable world was called into existence long previous to the creation of animals, and to this period is referred the formation of the coal strata. There might have been an epoch when the disturbed condition of the earth—its earthquake shocks, and volcanic strugglings—may have poured so large a quantity of carbonic acid into the atmosphere, as to have rendered this planet unfit for the habitation of animals, until a teeming and most gigantic vegetation, by exhausting it for its own supply, purified the air and rendered the more quiet earth a fitting abode for creatures endowed with reason and with instinct. But the hypothesis is unsupported by facts, and it is not within the range of probabilities that the animal and vegetable kingdoms can ever have an independent existence.

The animal kingdom is constantly producing carbonic acid, water in the state of vapor, nitrogen, and in combination with hydrogen, ammonia. The vegetable kingdom continually consumes ammonia,

nitrogen, water and carbonic acid. The one is constantly pouring into the air what the other is as constantly drawing from it, and thus is the equilibrium of the elements maintained.

Plants may be regarded as compounds of carbon, vapor, oxygen, hydrogen, and nitrogen gases, consolidated by the all-powerful, all-pervading influences of the solar ray; and all these elements are the produce of the living animals, the conditions of whose existence is also greatly under the influence of these beams of sunlight which are poured in unceasing flow from the center of our system.

Can anything more completely display a system of the loftiest design and most perfect order, than these phenomena?

THE SOLAR RAYS AND THEIR INFLUENCE ON CHEMICAL COMBINATION.

There are many examples which show clearly the influence of the solar rays upon chemical combination. Here are a few remarkable instances which are worth our notice. Vogel observes, that if chlorine was passed into alcohol nearly saturated with that gas, and at the same time exposed to the sunshine, each bubble of chlorine, as it entered the spirit, exploded, giving a bright purple flame and a white vapor. This experiment I have repeated and found that the effect depends entirely upon the agency of the chemical radiation. The interposition of an orange glass, or a yellow fluid, is quite sufficient to stop this energetic chemical combination.

It has long been known to chemists, that a mixture of chlorine and hydrogen gases might be preserved in darkness,without combining for some time, but that exposure to diffused daylight gradually accomplished their combination, whilst the direct solar rays produced the sudden inflammation of the mixture. This combination has been investigated by Gray, Lussac, and Thenard, and also by Davy. Sir Humphry Davy states that in mixture, chlorine and hydrogen acted more rapidly upon each other, combining without explosion, when exposed to the red rays, than when placed in the violet rays. But he found that a solution of chlorine in water became a solution of muriatic acid most rapidly when placed in the refrangible rays. The former statement is doubtful.

My own experiments appear to show that the combination of these gases may be effected in every part of the prismatic spctrum, but that it is entirely independent of the luminous rays. I have kept chlorine and hydrogen without uniting, behind a yellow medium, for as long a period as I have been able to preserve the mixture in the weakest diffused daylight. It does not, however, appear to be quite independent of calorific

influence; for it is found that the combination is effected gradually under the influence of the dark rays of heat.

We have evidence to show that the chemical agent, whatever it may be, which accompanies light, is diffused over every part of the prismatic spectrum, although its action is modified by the luminous and calorific influences. Now, as it is proved that a very small amount of actinic power will occasion the chemical combination of these gases, we can well understand that it is diffused over the whole of the rays, although in different degrees.

Dr. Draper has shown that the light of a taper produces a decided effect upon the mixed gases, chlorine and hydrogen, and also that the light emitted during the rapid passage of the electric spark, acts powerfully upon them. For speed of action no tithonographic[1] compound can approach it; a light which perhaps does not endure the millionth part of a second affects it energetically. In the red the chemical influence is pretty active, and this, combined with the thermic power of that ray, accounts for the phenomenon observed by Davy. I have found, however, that the combination is effected with the greatest speed by the extreme blue and indigo rays. Dr. Draper has fixed the maximum in the indigo rays, and giving a numerical value to the forces exerted by the different rays, he calls the maximum power of the

Indigo ray	240.00
Blue ray	144.00
Violet ray	121.00
Green ray	54.00
Extra spectral ray	12.00
Yellow ray	2.00
Orange ray	.75
Red ray	.50?

The red ray should have a much higher power than is here stated, as it is found it is quite equal to the green ray, and I think superior to it in effect, since it has been shown that if glass tubes of small bore are used, the combination of the gases can be effected without any explosion.

Taking advantage of the action of the sun's rays upon these gases, Dr Draper devised an instrument for measuring the chemical force exerted by light. This instrument consists essentially of a mixture of equal volumes of chlorine and hydrogen which is evolved from and confined over muriatic acid, in a graduated bent tube. The gases are lib-

[1] *Tithonicity* was a name given by Dr. Draper to the chemical rays, but which is perhaps badly chosen; and certainly not at all in accordance with the Lavoiserion principle of nomenclature.

erated from the liquid acid by the agency of galvanic electricity. Platinum wires, which can be connected with a voltaic battery, are inserted into the tube in such a manner that when the required quantity of the gases is formed the decomposition ceases, owing to the fluid having fallen below the wires. The gases combine in a longer or shorter time, according to the amount of light, the number of degrees over which the fluid falls in the graduated arm in a minute giving relatively the force in action. This instrument is certainly a very ingenious application.

The formation by the sun's rays of precipitates which do not occur in the dark, has engaged the attention of Sir John Herschel; but further investigations are required. Phenomena which have been observed lead me to believe that under no circumstances, where the changes are gradual, does precisely the same thing take place in darkness as in daylight. As far as observations have gone, it is found that in all cases where precipitation does not take place immediately upon mixing two solutions, there is a very marked difference in the time required for precipitation to ensue in a fluid kept in the dark, and in one exposed even to diffused daylight, this being, of course, more strikingly shown if one fluid is placed in the sunshine.

Chlorine, iodine and bromine, it is well known, act with considerable energy upon metallic bodies. If, however, any polished metal is exposed to the action of them in a diluted state, the combination is at first exceedingly weak, and the films that are formed by either of these three elementary bodies upon any metal, undergo considerable change under the influence of the sun. In most cases it appears that these bodies are set free, and the metal left in a state of very fine division or oxidization.

Copper, tin, iron, zinc, lead, pewter, bismuth and several other metals have offered the same results. It is still more remarkable, that films of bromine or iodine on glass are found, under the action of the sun's ray, to act in a similar manner; and in 1841 a scientist of note whose name I cannot find, published in some magazine a full account of the power of iodine in rendering wood capable of receiving photographic images.

In connection with this section of my subject, the following observation and experiments of Dr. Franklin are most important. They are abstracted from his "Researches on the Organic Radicals," published in the *Quarterly Journal of the Chemical Society.*

"Scheele, Seebeck, and others found that nitric acid exposed to sunlight is converted into nitrous acid and oxygen, whilst many metallic oxides lose the whole or part of their oxygen; thus peroxide of lead is resolved into metallic mercury and red oxide, whilst red oxide of mer-

cury, under water, is decomposed into grey oxide and oxygen gas.

"It has been long known, that certain inorganic bodies, containing iodine, such for instance as the iodides of silver and gold, undergo decomposition when exposed to light, the iodine compounds of the noble metals appearing to be most susceptible to this change.

"From the close relation of hydrogen to these metals, its iodide might be expected to possess the same susceptibility and this is, in fact, found to be the case; for it is well known, that aqueous hydriodic acid, even when preserved in closely stopped bottles, gradually turns brown on exposure to light, from the separation of free iodine, but the decomposition only becomes continuous when the iodine is removed as fast as it is liberated; it has also been observed, that when hydriodic acid gas is allowed to stand over mercury, its volume becomes reduced to one-half, and the residual gas consists of pure hydrogen; but whether this reaction only occurs under the influence of light, has not been clearly established.

"It has been remarked by almost all chemists who have had occasion to employ iodide of ethyl, that this liquid becomes brown from the separation of iodine when exposed even to diffused daylight; this observation, which I have myself of late also frequently had an opportunity of making, induced me to hope that a decomposition here occurs analogous to that suffered by the iodide of hydrogen under the same influence. I find that the ethyl compound when exposed to direct solar light, rapidly becomes of a dark brown color; but, as is the case with hydriodic acid, this separation of iodine soon ceases, and when a certain intensity of color has been attained no further action takes place; if, however, the free iodine be removed by agitating the liquid with mercury, the action immediately recommences and proceeds to the same point as before. This behavior of the iodine under light and in contact with mercury, indicated the method by which the action could be carried on continuously and the products collected and preserved.

"For this purpose several glass flasks of about 10 ounces capacity were filled with mercury, and inverted in a vessel containing the same metal, a few drops of iodide of ethyl being then introduced into each by means of a pipette; they were exposed to the direct rays of the sun. The surface of the mercury where it was in contact with the liquid, soon became covered with a film of proto-iodide, which, by the further action of the light, was converted into biniodide, whilst bubbles of gas were continually evolved and gradually displaced the mercury from the flask; finally, the whole of the iodide of ethyl disappeared, the gas and biniodide being the sole products of the decomposition. Although simple exposure to the sun's rays caused this action to take place with tol-

erable rapidity, yet it was greatly accelerated by placing each flask near the focus of an 18-inch parabolic reflector, which was not, however, so highly polished as to cause a very considerable elevation of temperature, the heat never rising to the boiling point of iodide of ethyl (71.6° C.).

"As iodide of ethyl is not in the least acted upon by mercury at a temperature of 150° C., it could scarcely be supposed that the comparatively low degree of heat at which these materials were exposed in the focus of the reflector could play any important part in the decomposition; yet, in order to set the question entirely at rest, an inverted bell-jar, containing iodide of ethyl, confined over mercury, was surrounded by a glass cylinder, and this latter filled, first with water, then with a solution of chloride of copper, and lastly with a solution of bichromate of potash. When the outer cylinder was filled with water, the decomposition proceeded with as much rapidity as without the intervention of that fluid, whilst the temperature of the water was scarcely perceptibly raised during the operation; the same was the case when solution of chloride of copper was employed; but on substituting the solution of bichromate of potash scarcely the slightest action was perceptible, even after several days exposure to bright sunshine.

"Now, since, according to Mr. Hunt at whose suggestion I employed these liquids, the solution of chloride of copper absorbs nearly all the heating rays and allows about 90 per cent. of the actinic rays to pass, whilst the solution of bichromate of potash intercepts the actinic and gives free passage to the heating rays, it is evident that the decomposition before us is due to the chemical influence of light, and is totally independent of the heating rays of the solar spectrum."

Based upon the above experiments and our knowledge of the action of light on chemical combination, I undertook a series of important experiments upon the effects of the administration of iodide of potash and soda, and mercury, in their various forms in the treatment of syphilis in its various forms.

Much to my astonishment, in cases where I could not get as rapid an impression upon the disease by the administration of these remedies in the usual way, I found that when the subject was placed under the electric arc-light, or in the pure sunlight, in a nude state, that these remedies acted almost magically and their impressions were noticeable in one-half the time than by the regular method of administration at our disposal. I had a number of mixed cases under treatment (that is syphilis, and tuberculosis of the lungs). I could not make as rapid a progress as I would have liked until I began the method of exposure of the body in a nude state half an hour after the administration of the iodide of soda, and mercury.

This combination of treatment in mixed cases of tuberculosis and syphilis will be found to give results that no other methods to date can possibly duplicate. Further on I have something to say of iron preparations upon which light acts within the body after their administration to which I call your attention most recommendably.

INFLUENCE OF THE SOLAR RAYS ON PRECIPITATION.

In 1832 Sir John Herschel communicated the remarkable fact, that when a solution of platinum in nitro-muriatic acid which has been neutralized by the addition of lime, and has been well cleared by filtration, is mixed with lime water in the dark, no precipitation, or scarcely any, takes place, but when (being thoroughly cleared of any sediment) this mixture is exposed to sunshine it instantly becomes milky, and a white or yellowish-white precipitate speedily falls.

By exposing this mixture behind colored media, Sir John Herschel found that the effect was due to the influence of the most refrangible rays. These mixtures another noted scientist placed in small glass tubes, and so arranged them that they were individually exposed to a separate ray of the spectrum; after an exposure of one hour the following results were obtained, the precipitates having been carefully washed and dried in the tubes in which they were formed.

Most refrangible rays beyond the visible spectrum...........	0.07 gr.
Violet rays...	1.05 gr.
Indigo rays...	0.60 gr.
Blue rays...	0.45 gr.
Green rays..	0.10 gr.
Yellow and Orange rays................................	—
Red rays..	0.05 gr.

It is a fact worthy of especial notice, that this precipitation is so dependent upon the amount of sunshine, that precipitates obtained in the same time, being carefully weighed off, will show the relative amount of actinic influence to which they have been exposed.

Manganate of potash: A solution of this body, having been made in the dark, was placed in two glass vessels and set aside. After having been kept in darkness for two hours, the solutions remained as clear as at first. One of the vessels with its contents was then removed into the sunshine, when the solution immediately became cloudy and was very speedily decomposed, the precipitate falling heavily. By experiments with the spectrum I have since found that the precipitation is due almost entirely to the more refrangible rays. I have not been enabled to decide with that degree of accuracy I could desire, in which ray the maximum effect is produced. The precipitates formed in the

blue, indigo and violet rays were nearly of the same weight, but it did appear that the precipitation was most speedily produced by the mean blue ray. After all my experimental research, I find that the blue ray is one of the most powerful chemical action rays in the entire spectrum.

If we dissolve the brown precipitate from the chameleon mineral in a solution of cyanide of potassium, we have a clear fluid. Reserve one portion in darkness, and expose another to direct sunlight; the solution preserved in the dark will remain quite clear for many days, whereas that exposed to actinic influence throws down a brown precipitate after a few hours' exposure.

When a few grains of sulphate of the protoxide of iron are dissolved in rain-water and kept in perfect darkness, the solution remains clear for a long time; it becomes, however, eventually cloudy and colored from the formation of some basic salt of iron, even in tubes hermetically sealed. A few minutes' exposure to direct sunlight is sufficient to produce this change, and the salt formed, instead of floating in the fluid and, as, in the former case, rendering it opaque, falls speedily to the bottom.

Of course I could go into this subject deeper, taking up the question of the solar action on various metallic compounds, non-metallic compounds, thermography in reference to the examination of all the phenomena connected with the supposed radiation of light in absolute darkness, phosphorescence, the magnetizing power of light, etc., but all this is beyond the pale of this paper.

ON THE SOLARIZATION OF THE NUDE BODY BY THE SUN OR ELECTRIC ARC RAYS AND THE PHYSIOLOGICAL AND PHYSICAL INFLUENCE OF THESE RAYS UPON IRON PREPARATIONS AFTER THEIR ADMINISTRATION.

I bring before your notice here one of the physical marvels which light is capable of producing upon the salts of iron, without and within the human body, or upon vegetation.

This physiological discovery has been followed up closely in its various aspects, and as a conclusion, I found that in the administration of iron-salts, in connection with the exposure thereafter of the patient's body to sunlight or the arc-light, an immediate physical and physiological change takes place, making it possible for metabolism to do the rest of the work, with results that are remarkable.

It is a noted fact that photographic chemistry has taught us much in many respects. We are indebted for nearly all the facts connected with the photographic properties of the salts of iron to the labors of Sir John Herschel. In his hands these salts have become valuable photo-

graphic agents; and two or three processes which have been devised are among the most interesting within the range of the photographic art. These various processes can be referred to in the many works on photography where the whole detail can be accurately studied.

I have found that nearly all the salts of iron, under the influence of the sun's rays or under the electric arc-light, for a longer or shorter period, undergo changes. Herschel found this fact:—Papers washed with the ferrosesquicyanuret of potassium exposed to the prismatic spectrum, proved that the decomposition of the salt and deposit of prussian blue is due to the action of the blue and violet rays below the blue, having absolutely no influence. The greatest activity appears to exist about the region of the indigo rays. The rationale of these different processes in photography has been well explained by Herschel. In nearly all cases the action of the sun's rays is a deoxidizing one. In the case of the ferrosesquicyanuret-of-potassium-process, where the paper is simply washed with the ferrosesquicyanuret of potassium, it is found highly sensitive to light. Exposed to sunlight for about an hour or less, with an engraving upon it, a beautiful negative photograph is the result. Really what happens physically is that oxygen which combines with hydrogen to form water is parted with. Prussian blue is deposited, the base being supplied by the destruction of one portion of the ferrocyanic acid, and the acid by the destruction of another. Herschel says: "It seems natural at first sight, to refer these curious and complex changes to the instability of the cyanic compounds; and that this opinion is to a certain extent correct is proved by the photographic impressions received on papers which have no iron but that which exists in the ferrocyanic salts themselves. Nevertheless, the following experiments abundantly prove that in several of the changes above described, the *immediate action* of the solar rays is not exerted on these salts, but on the iron contained in the ferruginous solutions, added to them, which it deoxidizes or otherwise alters, thereby presenting it to the ferrocyanic salts in such a form as to precipitate the acids in combination with the peroxide or protoxide of iron, as the case may be.

To make this evident, all that is necessary is simply to *leave out the ferrocyanate* in the preparation of the photographic paper which thus becomes reduced to a simple washing over with the ammonia-citric solution. * * * If a slip of this paper be held for any four or five seconds in the sun, or arc-light (the effect of which is quite imperceptible to the eye) and when withdrawn into the shade be washed over with the ferrosesquicyanate of potash, a considerable deposit of prussian blue is formed on the sunned part, and none whatever on the rest, so that on washing the whole with water, a pretty strong blue impression is left,

demonstrating the reduction of iron in that portion of the paper to the state of protoxide. The effect in question is not, it should be observed, peculiar to the ammonia-citrate of iron. The ammonia- and potasso-tartrate fully possess, and the perchloride, exactly neutralized, partakes of the same property; but the experiment is far more neatly made and succeeds better with other salts.

If this salt is mixed with perchloride of iron, and washed over paper, whilst it is exposed to the spectrum, the action is continued down to the very end of the thermic spectrum. The formation of the deposit color in this region is accompanied with phenomena of a novel character, referable to the heat developed by the thermic spectrum. Oval brown spots are formed which correspond with the heat spots referred to, and which are evidently due to calorific agency. If ammonia-citrate of iron is used instead of the perchloride, "a copious and richly colored deposit of prussian blue is formed over the whole of the blue, violet and extra spectral rays in that direction, extending downward (with rapid graduation) almost to the yellow in the spectrum." If the action of light is continued, the blue and violet rays in a very strange way destroy their own work. "A *white* oval makes its appearance in the most intense part of the blue, which extends rapidly upwards and downwards; at a certain point of the action the upper or more refrangible extremity of the white impression exhibits a semicircular termination, beyond which is a distinct and tolerably well defined conjugate image, or insulated circular white spot, whose center is situated far beyond the extreme visible violet."

As far as my researches have gone, all the persalts of iron are converted into proto-salts by exposure to sunlight and electric arc-light rays, when in combination with organic matter. This has beeen most fully confirmed and even in soils all the persalts are changed to proto-salts of iron by the action of growing vegetable and light. I have reasons for believing that all the proto-salts undergo some change. What this change may be it is impossible to say at the present stage of the inquiry, but it will be seen that scarcely any of the metallic salts resist the agency of the sun's light or arc-light rays.

It was these facts that first led me to undertake a number of physiological experiments to test the value of the different salts of iron in conjunction with light administration. In over one hundred tuberculous patients the different iron salts and organic preparations of iron were administered and the patients placed daily in the way of the sun's rays and electric arc-light. Much to my surprise I found that the iron salts (organic iron preparations) were taken up most rapidly, showing marvelous constitutional effects. After the first week the blood counts

proved their richness in number to an enormous amount, as compared with previous counts, by the older methods of administration and with other preparations by the old daily method. The haemoglobin increase was very marked.

To-day for the first time since my experimental work, I bring this new method before your notice, knowing of nothing more powerful that will assist in supplying iron to the system more rapidly than usual, in cases where it is indicated, than this method of administering salts of iron in combination with light. We also know that iron in various forms is being introduced daily into the system by many articles of food; light affects these forms of iron in exactly the same manner as if it were taken in the form of the salts. It is often a good plan, where it is feasible to allow the eating of such foods and vegetables as much as possible. I have taken notice of this fact in a number of cases and must say very satisfactory results have been obtained. Amongst the different forms of iron and its compounds, that I made use of in my investigations, were the Blaud's pill in capsule in a fresh state, the ammonia-citrate of iron, carbonate of iron, tct. chloride of iron, and Tropon. This organic compound with iron was selected by me upon its merits; I found it contained vegetable and animal materials in such a state as light would perhaps have a rapid action upon. Much to my own surprise I noticed that this organic food with an iron preparation showed important therapeutic results after a very short time. It also gave the least digestive disturbances, as compared with the others. Hard boiled eggs and iron powder gave me excellent results. All iron preparations exhibited in connection with light rays, left beyond a doubt their physiological workings.

HINTS IN CONNECTION WITH THE ADMINISTRATION OF LIGHT RAYS.

White or light colored clothes transmit more light to the body than those of any other color, while black or dark colored clothes absorb the light and degrade it into the coarser principle of ordinary heat. You may ask me the question: Is not an object white from the fact of its reflecting all the colors? How then can it transmit them? I answer you as follows: The white reflects a large amount of all the rays, but all those rays which penetrate the interstices of a white garment sufficiently far, pass in as white ones beyond it from the repulsive nature of all the threads, while a black garment from its great affinitive attraction for all the rays greedily absorbs them and prevents their escape on the other side. A sufficient proof of this is the fact that a black or blue curtain will darken a room far more than a white or buff-colored one. But the dark colored curtain of itself will be warmer than the white

one. The experiments of Dr. Franklin, in which he put various colored cloths on the snow, are well known. The darker the color of the cloth, the more deeply did the snow melt beneath it under the solar rays. But this does not signify that the black transmitted more heat, but absorbed it, and the garment thus warmed melted the snow because of contact with it. If the cloths had been placed some distance above the snow, the light colors, transmitting the heat more rapidly, would have melted the snow more quickly, just as we see that yellow and orange and red glass transmit more heat than the blue.

The rule is, that if radiant heat "be entirely transmitted, no elevation of temperature is produced in the body through which it passes," and the very fact that a body grows warm under the heat rays shows that the rays are not transmitted, but absorbed.

It is for the above reasons that all clothing for general wear of tuberculous patients should be made up from the lightest colored materials (preferably all white garments, down to the underclothing). This is highly commendable. The nude state of the entire chest down to the waist exposed daily for several hours, is, of course, still better. I have seen most wonderful results from the exposure of the entire body in a nude state in solaria which were built for several of my patients, and which had all the appointments suitable for the different seasons of the year.

We read in the history of ancient Greece how the inhabitants had small terraces, in the form of solaria built on the tops of their houses, and in which they took their daily sun baths. There is nothing to prevent the owners of general dwellings from providing for their tenants, a solarium, built above the body of every house on the roofs and furnishing it with modern appointments, making it useful both in winter and in summer. If provisions are made for the certain days in which the sun's rays are not accessible, the electric arc-lighting may be resorted to. This takes the place of the sun's rays. In this manner a continuous use of light rays may be had at all times.

This method should be employed in every hospital that professes to treat the consumptive according to modern principles.

Children who are weaklings and those who are pretuberculous should be reared in solaria for several hours daily. The solarium should be so constructed that it would be independent of climatic conditions, from every point of view. I have had a number of practical clinical experiences, within the last ten years, with solaria and I commend their use in the highest terms.

Gymnastics must also be practiced in the nude state and hydrotherapeutics added to the treatment in general.

We have thus seen that the magnetic, electric powers of the sun's rays reside in the violet ray, which is a compound of the blue and red rays. These constitute what are termed the chemical powers of the sunlight. That they are the most important powers of nature, there can be no doubt as without them life cannot exist on this planet. Without these chemical powers there could be no vegetation or anything else.

Light is inimical to, and under favorable conditions may wholly prevent, the development of organism. The action of light entirely destroys the bacteria, or reduces them to a condition of torpidity which requires months of darkness in favorable surroundings for them to overcome. In my experiments, I took small test tubes containing cultivation fluid, which were suspended in deep, narrow boxes made of garnet, red, yellow, blue and ordinary glass, respectively. Although the blue and yellow glasses were not monochromatic, the results showed that the action is chiefly dependent on the blue and the violet rays.

It is probable, therefore, that if the phenomena were represented by a curve, the maximum elevation would be found in or near the violet. The organisms, with which many of the experiments were carried out, afford an example of protoplasm in a simple and uncomplicated form, but it would be unreasonable to suppose that this protoplasm is so essentially different in its fundamental constitution from all of the protoplasm, that here, and here only, is this special effect of light to be found. There are many facts which prove the contrary and indicate, not with a special and fortuitous phenomenon, but with a general law.

I have found that not all the rays of the spectrum are able to exert an influence upon the direction of the movement of the spores, it being only those which are strongly refracted (blue, indigo and violet) that produce stimulation. If a vessel containing a deep-colored solution of ammoniated copper oxide which only transmits blue or violet rays, be placed between the source of light and the preparation, the spores are seen to react just as if they came in contact with ordinary white light; on the other hand, they do not react at all to light, which is passed through bichromate of potassium solution, through the yellow vapor of a sodium flame, or through ruby-red glass; another very important and complex manifestation of the effects due to light is seen in the movements of the chlorophyll corpuscles.

Light acts as a stimulus to animal and plant protoplasm. It induces characteristic changes of form in individual cells and causes movements in fixed directions in free-living unicellular organisms.

I have discovered, by experiment and practice, the special and specific efficacy in the use of the combination of the calorific rays of the sun,

and the electric arc-light in stimulating the glands and cells of the body, the nervous system generally, and the secretive organs of man and animals. It, therefore, becomes a most important adjuvant element in the treatment of acute and chronic diseases, especially such as have become chronic, or result from derangement of secretive, perspiratory or glandular functions, as it vitalizes and gives renewed activity and force to the vital currents that keep the health unimpaired, or restore them when disordered or deranged.

SOME STUDIES OF THE INFLUENCE OF THE ELECTRIC ARC-LIGHT UPON GREENHOUSE PLANTS.

At the agricultural experimental station of Cornell University in the winter of 1889 and '90, some experiments on an extensive scale were carried out to determine what influence the ordinary electric arc-light exerts upon plants in greenhouses. Much has been said among gardeners concerning supposed retarding or accelerating influences of the arc-light upon plants. Many have supposed that the electric light can be introduced profitably into greenhouses for the purpose of hastening growth. The general opinions varied on this subject until these experiments and those by the Horticultural Department of Washington settled some of the most important points in connection therewith.

The first experiment to determine the influence of electric light upon vegetation was made by Herve Mangon in 1861.[1] This experiment showed that the electric light can cause the production of chlorophyll, or green color to plants, and also, that the light can produce heliotropism, or the phenomenon of turning or bending towards the light.

In 1869, Prillieux[2] showed that the electric light in common with other artificial lights, is capable of promoting assimilation, or the decomposition of carbon dioxide in water. The next experiments appear to have been those of C. W. Siemens, in England, and P. P. Deherain, in France. These two, with those of Cornell and the Washington Horticultural Department appear to be the only definite investigations of this subject.

The English experiments, although eminently practical, were conducted by an electrician, and the French were largely confined to physiological problems. It seemed proper that the third series of experiments should be approached from the particular standpoint of the gardener.

Dr. Siemens' experiments may be divided into two series: In one series the lamp was placed inside the greenhouse, and in the other

[1]Compt., Rend. 53, 243.

[2]Compt., Rend. 69, 410.

suspended over it. In both cases he observed marked effects upon vegetation in a short time.[1]

A great variety of plants was treated. The dynamo which Siemens used in his first experiment, "makes 1,000 revolutions a minute; it takes two horse-power to drive it, and develops a current of 25 to 27 meters, of an intensity of 70 volts". The light produced is equal to 1,400 candles measured photometrically..

When the lamp was placed inside the house, plants within three or four feet of it suffered much, the leaves of the melons and cucumbers "which were directly opposite the light turning at the edges and presenting a scorched appearance." When these injured plants were removed to a distance of seven or eight feet, they showed "signs of recovery, throwing out fresh leaves, with pearls of moisture at their edges." In general, plants which were exposed to normal conditions during the day and six hours of electric light at night far surpassed the others in darkness of green and vigorous appearance generally." The flavor was fully as good in the electric light fruits as in the others. The results were supplemented by larger experiment in the winter of 1880 and 1881.

In this case a lamp of 4,000 candle-power was used, and it was placed inside a house of 2,318 cubic feet capacity. The light was run all night, and the arc was at first not protected by a globe. The results were anything but satisfactory, the plants soon becoming withered. At this point a globe of clear glass was placed upon the lamp and thereafter the most satisfactory results were obtained. Peas, raspberries, grapes, melons and bananas fruited early and abundantly under continuous light—solar light by day and electric by night.

The strawberries are said to have been of "excellent flavor and color" and the grapes "of stronger flavor than usual." The bananas were "pronounced by competent judges unsurpassed in flavor," and the melons were "remarkable for size and aromatic flavor." Wheat, barley, and oats grew so rapidly that they fell to the ground of their own weight. The beneficial influence of the clear glass globe was therefore most marked. The effect of interposing a mere sheet of thin glass between the plants and the source of the electric light was most striking. On placing such a sheet of clear glass so as to intercept the rays of electric light from a portion only of a plant—for instance a tomato plant—it was most distinctly shown upon the leaves. The portion of the plant under the direct influence of the naked electric light, though a distance

[1] *Proc. Royal Soc.*, XXX, 210 and 293. *Rep. British A. A. S.*, 1881, 474. See also abstract in *Nature*, XXI, March. 11, 1880, and an editorial in the same issue.

from it of nine or ten feet[1] was shrivelled, whereas that portion under cover of the clear glass, continued to show a healthy appearance, and this line of demarkation was distinctly visible on individual leaves; not only the leaves but the young stems of the plant soon showed signs of destruction when exposed to the naked electric light, and those destructive influences were preceptible, though in a less marked degree, at a distance of twenty feet from the source of light."

In other series of experiments Siemens placed an electric lamp of 1,400 candle-power about seven feet above a sunken melon pit which was covered with glass. The light was modified by a clear glass globe. In the pit, seeds and plants of mustard, carrots, turnips, beans, cucumbers and melons were placed. The light ran six hours each night and the plants had sunlight during the day. It all cases those plants "exposed to both sources of light showed a decided superiority in vigor over all others, and the green of the leaf was of a dark rich hue." Heliotropism was observed in young mustard plants. Electric light appeared to be about half as effective as daylight. A great difficulty experienced in this experiment was the films of moisture which condenses on greenhouse roofs at night, and obstructs the passage of light. The light was at one time suspended over two parallel pits nearly four feet apart, and the effect was observed upon plants under the glass and in the uncovered space. In all cases the growth of the plants was hastened. Flowering was hastened in melons and other plants under the glass. Strawberries which were just setting fruit, were put into one of the pits, and part of them were kept dark at night, while the others were exposed to the light. After fourteen days, the light having burned twelve nights, most of the fruits on the lighted plants "had attained to ripeness and presented a rich coloring, while the fruit on those plants that had been exposed to daylight only, had by this time scarcely begun to show even a sign of redness." He concludes that a lamp of 1,400 candle-power produced a maximum beneficial result at a distance of three meters (nearly 10 feet) above the glass but "the effect is nevertheless very marked upon plants at a greater distance."

At the close of his experiments Siemens was sanguine that the electric light can be profitably employed in horticulture, and he used the term "electro-horticulture" to designate this new application of electric energy. He anticipated that in the future "the horticulturist will have the means of making himself practically independent of solar light for producing a high quality of fruit at all seasons of the year."

[1]It is to be observed that the light used by Dr. Siemens' in this case was 4,000 candle power.

He had shown that growth can be hastened by the addition of electric light to daylight, that injury does not necessarily follow continuous light throughout the twenty-four hours, that electric light often deepens the green of leaves and the tints of flowers, and sometimes intensifies flavors, and that it aids to produce good seeds; and he thought that the addition of the electric light enabled plants to bear a higher temperature in the greenhouses than they otherwise could. But whatever may be the value of electric light to horticulture, the practical value of Siemens' experiments is still great. They have furnished data in several obscure relations of light to vegetation. *Nature* made the following comments upon this feature of the application of the electric light by Dr. Siemens: "But the scientific interest of its present application must rest mainly on the fact that the cycle of the transformation of energy engaged in plant life is now complete and that we can run through the changes from heat to electricity and thence to light, which now we know we can store up in vegetable fuel again."

Deherain's experiments were conducted at the *Exposition d'Electricite*, Paris, in 1889. A small conservatory standing inside the exposition building was divided into two compartments. One compartment was darkened and the glass painted white upon the inside; this received the electric light and all solar light was excluded. The other compartment was not changed. The amount of sunlight which the plants normally received in this conservatory within an exposition was not sufficient to maintain a healthy growth. A lamp of 2,000 nominal candle-power was used. At first the naked electric light was used and it ran continuously. Barley in head and flax in flower were brought into the lighted compartment; also chrysanthemums, pelargoniums, roses and a variety of ornamental plants. After seven days of continuous electric lighting most of the plants were seriously injured.

All the pelargoniums lost their leaves, cannas were discolored, four-o'clocks were tarnished and bamboos were blackened. "But the most curious effect was produced upon the lilacs; all the parts of the leaves that had received the direct rays from the lamp were blackened, while those protected by the upper leaves preserved their beautiful green color, and the impression produced upon the epidermis by the electric rays had the clearness of a photographic plate." Similar effects were produced upon azaleas, dentzias, and chrysanthemums. It was found that this discoloration did not extend beyond the first layer of palisade cells. Plants which received solar light by day and electric light at night were injured in the same manner, but only in a less degree. The injury was most marked upon the old leaves. The pelargoniums soon sent out new shoots and the young leaves resisted the action of the

light much longer than did the mature ones. The flax continued to grow and the barley ripened. It was found that plants under the electric light alone were able to assimilate, but the action was very slow. As much assimilation took place in an hour on a bright summer day as in several days of electric light. At the expiration of two weeks the condition of the plants was so bad that a change was made, and thereafter a globe was used upon the lamp.

The experiment with modified light by use of a transparent glass globe was conducted like the preceding. Sprouting seeds in electric light alone grew for a short time, then drooped and died, not being able to make true leaves. Sprouting maize turned black, but maize in full growth remained in apparently good condition, though not growing even for two months. New leaves appeared on roses and other plants, but growth was slow or none. Flowers did not appear, and seeds did not mature in previously formed fruits, except in the case of barley, which made good seeds. New growths appeared at the base of some plants, and the petioles of pelargoniums became very much elongated. Many plants remained almost stationary throughout. Assimilation was more feeble than under the naked light. Plants which had been set out of doors during the day and brought into the electric light house at night did not behave any better, if as well, than those left out of doors continuously.

Deherain's account was replete with interesting speculations upon the physiology of the plants under experiment. His general conclusions of the influence of electric light upon plants are as follows:—

1. The electric light from lamps contains rays harmful to vegetation.

2. The greater part of the injurious rays is modified by a transparent glass.

3. The electric light contains enough rays to maintain full-grown plants two and a half months.

4. The light is too weak to enable sprouting seeds to prosper or to bring adult plants to maturity.

Finally, observations were made more recently upon the influence of the electric light upon plants in the winter palace at St. Petersburg. It was observed that in a single night ornamental plants turned yellow and then lost their leaves. Yet it is well known that incandescent lamps can be lodged in the corolla of a flower without injuring it.

I refer you to the literature for fuller information than it is here my privilege to give.[1]

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[1] *Cornell University Agricultural Experiment Station Bulletin*, 30, August, 1891; *Electro-Horticulture Bulletin*, 42, Sept., 1892; Hatch, *Experimental Station of Massachusetts Agricultural College Bulletin*, 23, Dec., 1893.

I however cite a few points which are clear:—"The electric light promotes assimilation, it often hastens growth and naturally, it is capable of producing natural flowers and colors in fruits; it often intensifies colors of flowers, and sometimes increases the production of flowers. The experiments show that periods of darkness are not necessary to the growth and development of plants. There is every reason, therefore, to suppose that the electric light can be profitably used in growing of plants.

The experiments suggest many physiological speculations upon which it is not the province of the bulletin to enter, yet two or three of them may be mentioned. It is a common notion that plants need rest at night, but this is not true, in the sense in which animals need rest. Plants have simply adapted themselves to the conditions of attending daylight and darkness, and during the day they assimilate or make their food, and during the night when, perforce, assimilation must cease, they use the food in growth. They simply practice an individual division of labor. There is no inherent reason why plants cannot grow in full light, and in fact, it is well known that they do grow then, although the greater part of growth is usually performed at night. If light is continuous, they simply grow more or less continuously, as conditions require, as they do in the long days of the arctic regions, or as our plants did under continuous light. There is no such thing as a plant becoming worn out or tired out because of the stimulating influence of continuous light.

It would seem, therefore, that if the electric light enables plants to assimilate during the night and does not interfere with growth, it must produce plants of great size and marked precocity. But there are other conditions, not yet understood, which must be studied."

Hundreds of these exemplary facts upon the action of light rays in connection with chemistry, physio-chemistry, physiology and phototherapeutics are known to us. The facts that I have cited here and there must suffice to give one an idea, at least, of the power that light exerts upon matter.

ELECTRIC ARC CROMOLUMES FOR GENERATING VIOLET RAYS OF LIGHT AS AN ADJUNCT TO THE TREATMENT OF TUBERCULOSIS.

In 1896 I published in the *New York Medical Journal*, some important remarks upon this subject, and since then have made many important chemical and physiological tests as to the power of light in therapeutics. Tuberculosis interested me mostly, so I dropped from

my list of researches many experiments which belong to other domains of medicine.

My specially constructed electric arc-light lamps for generating violet rays of light, (color light or chemical rays) have undergone many changes since my early experiments. I found that concentration of light would mean a great factor in the development of this principle and therefore more generating power was a necessity. This gave these parallel rays much more penetrating capacity for dense tissues; I therefore reconstructed my older models, and now use the apparatus as illustrated. Next came the question of simplicity of construction and management. I have succeeded in this undertaking after many trials.

These illustrations show several types used by me in my daily clinical practice which have proved most satisfactory as to results. These types of lamps are capable of generating rays of the highest quality, besides having the power of penetration.

I showed that concentrated rays of light as produced from an electric arc lamp of high power pass through the solid tissues as well as through bone, by allowing these rays to fall directly upon the chest-wall and, as a proof of this fact, printing from a negative plate or film upon a sensitive plate, and subject matter thereon, in less than fifteen minutes. This test, as I say, has again been confirmed by Dr. J. W. Kime, of Fort Dodge, and he differs in the method employed by me by using concentrated sunlight, instead of the electric arc.

As far as my clinical record goes, I can say here, that I have employed these colored rays of light as an adjunct to the general treatment of tuberculosis of the lungs with the most successful issue in sixty cases. I find that electro-arc solarization can claim for itself a rank as one of the greatest tonics and bacterial destroyers. There are many scientific facts regarding the chemical and physiological action upon the system which need study. Still, several which I have already studied and made use of, seem to fill the long-felt want in the treatment of this disease.

Of these sixty cases, I can report forty cured, and in twenty the disease was arrested to such an extent as the pathological changes present when they came under treatment, would admit. I now fully believe from my experience that, as an adjunct, light rays play a leading rôle in the treatment of tuberculosis. I want to stand upon these remarks for a future record.

The administration of these rays must be understood from the very first. Dosage, and how given, plays an important part, and no one should attempt to use them homeopathically. Long exposure is one of the prime rules—nothing less than a half-hour over the nude surface of

the selected areas; however, a longer time is preferable for each sitting.

A simple description of these electro-arc generators of the chrom-rays, and the method of employing them is essential. I gave these lamps the name of *electro-arc chromolumes*, as they are the sole producers of these specific colored rays. Their construction is so simple that their management does not require any study. They are all capable of giving from 2,000 to 20,000 candle-power or more. This high candle-power or efficiency is dependent upon the amount of current at one's disposal. There is no difficulty in getting any amount of electric current for their operation. All that is necessary is to have the room wired with an exact thickness of carrying efficiency, and then to have a transformer of exact size—which any company is always ready to furnish on application.

My own plant is furnished with a 40 amperes current transformer and the lamps are so constructed that more or less current does not affect them. By this arrangement any one can change his installation according to his work.

Each lamp for generating these chemical rays has fitted to it, one rheostat, and therefore, more than one generating lamp can be set in operation at the same time, and in the same room or elsewhere. Also they can be installed to operate on a single rheostat in such a manner that any special lamp may be selected where there are more than one in use. There are several different types of my lamps now on the market and they are made suitable to the differnt electric currents, for the high tension and the low tension (the alternating or the Edison direct current), as this was a most necessary point to be considered. For the high tension current, I constructed a lamp which operates both automatically and as hand-fed. This lamp, in order to get a steady and pure light spot, is provided with a concave mirror, and a moving gear for adjusting the focal lines—a most important device, this adjustment—as the focal parallel lines can be changed to the exact spot wanted. The focal spot ranges from 3 1-2 inches to 17 1-4 inches of concentration. By this means any part of the pulmonary apex or other portion of the anatomy can be treated accordingly. For the low tension, (Edison direct current) the lamps are different. The focal lines are created by a Mangin's mirror on the principle of the search-light, and have the same advantages as the other lamps.

A screen and hood, carrying a shutter on the front of the lamp, for cutting down the size of the light spot to be used, according to the area to be covered with the light rays, accompanies every electro-arc chromolume. This screen is a piece of additional apparatus and is for the purpose of screening the heat rays emitted during the operation of

the lamp upon a selected surface with a high concentration of the light-beam, for any length of time. It consists of blue glass, cut in strips, set in a framework, on a movable stand, capable of many changes of position.

All these generating lamps are mounted on stands which give any angle of motion suitable for application. The entire lamp, screen, etc., can be removed over any area of the operating chamber. They have long cables attached to the lamps, coming from the electric feeder of the installation. I have used several of these types and each one has its own particular value.

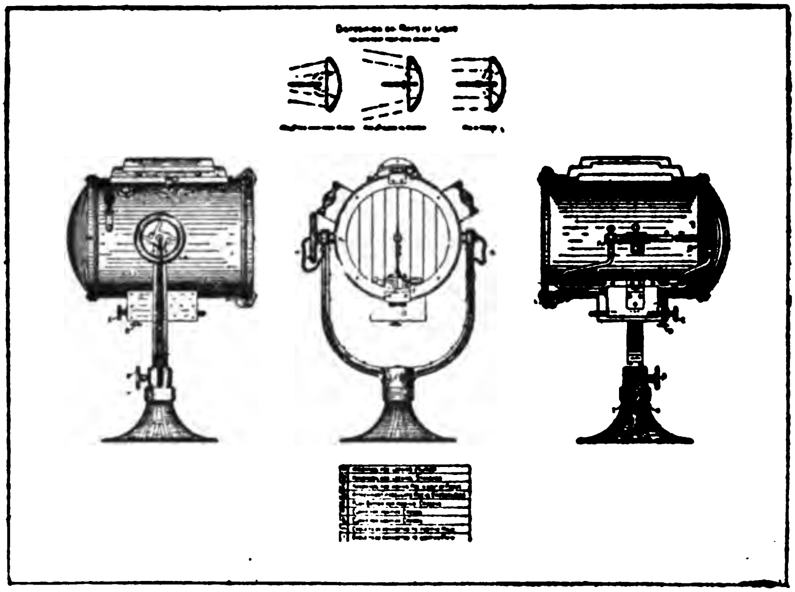


Fig.20. Diagram of the of the Electro-Arc Chromolume showing the details of its working.

The new types which I illustrate are adaptable for all purposes; one can get a concentrated beam from one-half to thirty or more inches. These illustrations speak for themselves. I present a photo by way of illustration, of the chromolume in full operation, taken from my earliest experimental work in 1894. This gives an idea how the light is applied to tuberculous patients.

GENERAL INFORMATION ON THE MANAGEMENT OF THE ELECTRO-ARC CHROMOLUME.

In focusing the lamps it is most important to note that the upper carbon is positive and in connecting the lamps the positive current must

flow to the upper carbon. The positive carbon is cored 12 inches long and negative solid 7 inches long; in these lamps the carbons burn in this proportion and thus keep exact focus. When 30 to 35 amperes is used the carbons should be of 5-8 diameter. Good carbons are necessary for good light, and the lamp is often blamed when fault lies with the carbons. These lamps have horizontal feed carbons; the positive is in the front holder with its point facing the mirror.

As before stated, it is necessary to see that the positive current flows to the positive or front carbon. Clamp in securely the long cored positive carbon and the short solid negative, so that the meeting point is the focus of the mirror; this varies according to the diameter of the mirror; the distance, approximately, is given in the following table. See that the carbons line up straight. The lamp box is on a movable carriage, the hand wheel at the rear of the lamp-case moves the lamp either nearer or farther from the mirror. If the lamp is too far forward the beam will have a dark center; by drawing the lamp closer to the mirror this will disappear and the beam will be clear and round and the rays of light entirely parallel. The mirror projectors are fitted with attachment to feed the carbons by hand if occasion should require. the arc-lamp burns at 45-48 volts. The lamp is perfectly steady on the low voltage of 50 direct incandescent circuit, but the rheostat supplied with the projector is regulated to any voltage as given.

TABLE OF THE DIFFERENT SIZES OF LAMPS AND CANDLE POWER.

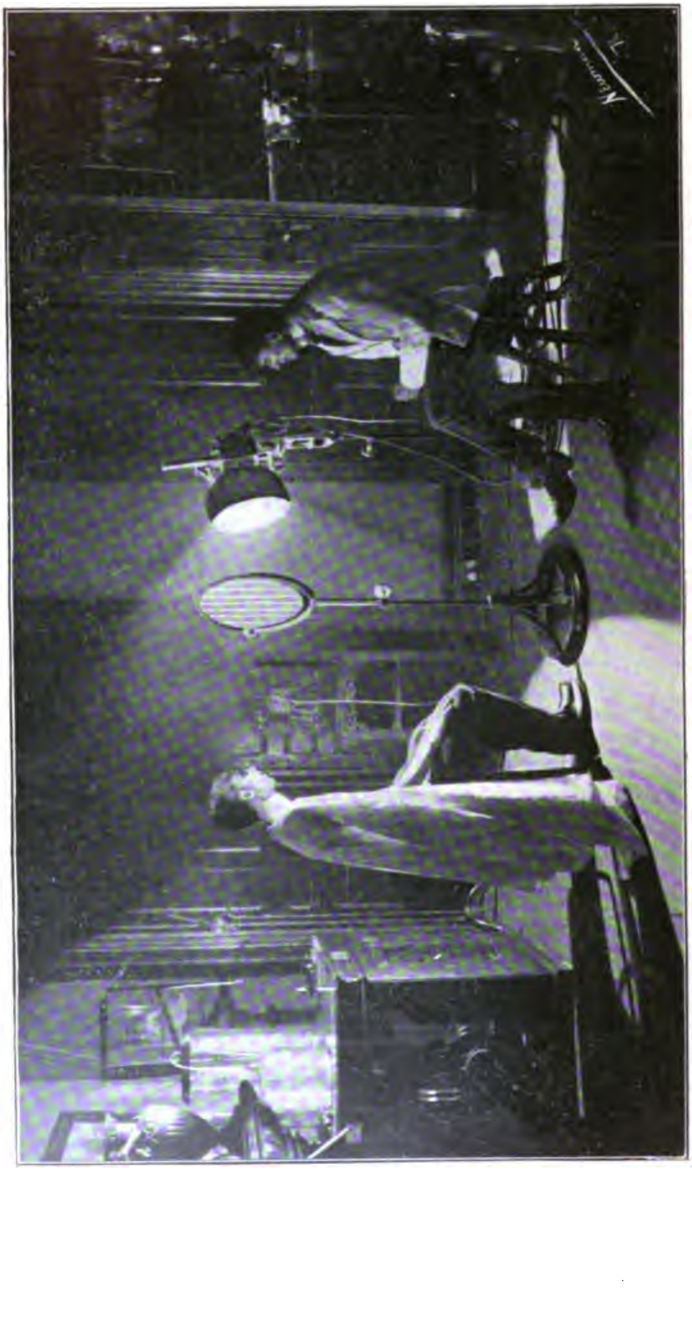
Diameter of Mirror.	Amperes.	Diameter Carbons. P.	N.	Candle Power at the Arc.	Candle Power Projected.	Focal Length.
7 in.	10	1-2 in.	7-16 in.	2000	8000	3 1-2 in.
9 in.	15	9-16 in.	1-2 in.	3000	12000	4 1-2 in.
12 in.	25	5-8 in.	9-16 in.	5000	20000	7 in.
16 in.	40	11-16 in.	5-8 in.	8000	32000	9 in.
20 in.	60	3-4 in.	5-8 in.	12000	48000	10 in.
24 in.	80	7-8 in.	3-4 in.	16000	64000	12 3-4 in.
30 in.	100	1 1-8 in.	1 in.	20000	80000	17 1-4 in.

Let me say, in concluding this short article on my chromolume, to those who will follow up this method of photo-therapeutics as an adjunct to the general treatment that they will be most amply paid for the trial. With light rays, hygienic food, fresh air, exercise and such suiable remedies as are indicated according to the case in hand, 75 per cent. of tuberculous patients are curable, that is curable to a certain extent, according to the lesions or pathological changes already present at the time the case comes under treatment.

Of course we all understand that pathological conditions which have in certain stages of this disease left their markings, cannot be changed. We cannot give the patient any more breathing capacity

Fig. 19. The Screen with Blue Glass.

Fig. 18. The Electro-Arc-Chromolume.



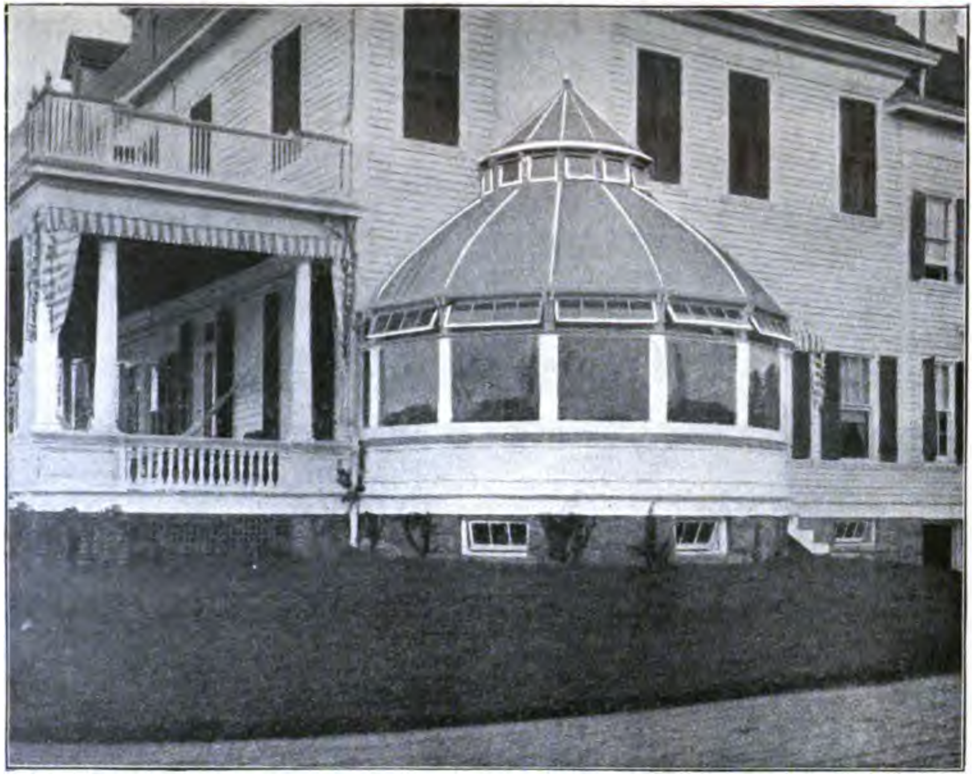


Fig. 21. Chromo Ray Solarium.

Fig.22. Chromo Ray Solarium.

after certain conditions become, so to say, stationary. Each case, however, is taken upon its own merits and treated accordingly; only such promises can be made to a patient as the existing pathological conditions will permit. There are, however, forms of tuberculosis which can be thoroughly cured, and a large majority, if they present themselves at an early stage are curable by this adjunct treatment within from 2 to 3 months. One important factor must always be remembered in this method, that much time should be alloted to each case—no less than an hourly sitting daily. This phototherapy is most admirably adaptable for sanatarium and hospital purposes. For years I have adopted a system of generating these colored rays of light. Where practical I have advocated the construction of solaria; these of course are more suitable to country than city use; also in a climate where the sunshine is in abundance.

The solaria must be constructed on plans which provide for all contingencies and the important necessities, heating, ventilating, cooling, glazing by colored glass intermixed with white glass, proper exposure, etc., are some of the principles embodied in their successful employment. Also proper exposure of the patient plays an important part in the treatment. The entire body should be exposed to this light for at least two hours or more daily.

I regret that my plan to publish in this Journal a complete treatise in sections on light from many important sides of the question, which it was my intention, failed. Nevertheless, I have tried in the space alloted me to give its readers sufficient of the subject matter that I may hope to stimulate more serious thought about light and its effects.

ICHTHYOL IN TUBERCULOSIS.

BY JOHN HEY WILLIAMS, M. D., ASHEVILLE, N. C.

In again bringing ichthyol to the notice of the profession as a remedial agent in the various forms of tuberculosis, I have tried to avoid any conclusions that were not based upon careful and exact clinical investigation. There is of late so much strenuous advocacy of some one particular remedy which in the hands of the exploiter has given unmeasured success, as to produce a spirit of incredulity in the minds of the more thoughtful. That these results cannot be obtained in the hands of others who are possibly as well equipped in every way and are as careful observers is certain. Extravagant and unfounded claims, made in such a way, tend to produce a spirit of pessimism or even nihilism in medicine. In this busy age one has little time to sit down

and winnow out the chaff for the few grains of wheat that may be found. It further tends to deter honest investigators from making public the results of painstaking and earnest endeavor to reach the truth.

While the researches of Koch and others, resulting in the advent of the tuberculin therapy, has given a renewed and intense interest to the study of tuberculosis, yet its failure in the hands of so many early experimenters has produced a spirit of atavism with a tendency to reversion to the modes and methods of our forefathers.

A careful study of the lines upon which our illustrious predecessors worked will serve to guide us in many ways, and we can draw many useful deductions from centuries of observation and empirical medication.

Our knowledge of medicine to-day is but the aggregation of the experiments of thousands who have gone before us. The improved instruments of precision, our improved technique in examination and the researches of our pathologists are the search-lights that give us a broader and deeper insight into the mysteries of perverted anabolism and katabolism which, after all, is disease.

A review of the treatment of tuberculosis from its earliest history will show that its dominant feature has been a study of the complex features of nutrition, and those remedial agencies which find most favor to-day are those that tend to the upbuilding of the impaired tissues of the body and the conservation of the vital forces. The careful study of the principles and processes of digestion, assimilation and the normal destruction of tissue in the body has been productive of much good in the therapy of the disease. While theories are as numerous as the observers, yet there is a substratum of similarity through them all. We know quite well what rest, and outdoor passive life, light and oxygen or air will do for our patients. Yet we know as well that there are remedies in our armamentarium that will materially aid us in the care of those unfortunates whom some of our brothers would make veritable Pariahs.

About fourteen years ago my attention was called to the therapeutic action of ichthyol when exhibited internally. This drug was first brought to our notice in 1883 by Unna of Hamburg. It was then exploited as a remedy for external application, but study of its chemical composition induced Professor Zuelzer, of the University of Berlin, to begin a series of observations in which he was ably seconded by Dr. Helmers. While Zuelzer noted his experiments upon others, Helmers experimented upon himself. Zuelzer states:—"It has a remarkable power to check waste; the urinary solids and the nitrogenous excreta

are somewhat diminished and under its administration the body weight increases; the income is promoted and the outgo lessened." Helmers found that it "restricted albumenoid disintegration, favored assimilation and supplied fully one-third of its free sulphur to the circulation, and was finally excreted by the urine, though slowly."

The high character and well-known accuracy of these eminent gentlemen induced me to give it a thorough trial in tuberculosis. Up to the present I have had over six hundred cases treated with ichthyol and have had most excellent results in many ways. My usage of the remedy has been based upon the fact that grave disturbance of nutrition has been one of the prime factors in all the cases that have come under my observation, and the remedy that favorably modifies tissue metabolism commands my attention.

I have given pretty thorough trial to creosote and while I find that in moderate doses I get a certain amount of improvement in my patients, yet there are certain limits to its exhibition. Gastric or duodenal catarrh is an absolute bar to its use and the inordinately large doses advocated by some conduce to this very condition.

Ichthyol is free from this objection and in even enormous doses has never in my experience produced any distress whatsoever, but, on the contrary, has relieved this condition, when preëxisting, in a great majority of cases. The scope of this paper will not admit of tabulated statistics and I shall content myself with the conclusions arrived at after careful study of the history of the cases I have charted. I have found that the appetite and digestion have improved with corresponding increase in weight and sense of well being. There has been a gradual reduction of night sweats with complete disappearance in a majority of cases.

While the bacilli gradually show degenerative changes with lessened number and final disappearance, I do not claim that these things are the direct or specific result of the exhibition of the remedy. A study of the pathological conditions incident to the caseation, softening and eventual expulsion of the liquified tubercle would instantly negative any such claim. But I think it may be clinically shown that the improvement in the tone and character of the cells composing the tissues in immediate proximity to the infected area with resultant sterilization of the soil is conducive to this end. The character of the cough changes and becomes easier as the expectoration becomes thinner and less tough and numular, takes on a more fluid character, is more easily raised and in quantity grows less. The observation of this fact has caused me to regard ichthyol as one of the most valuable expectorants at our command. Combemale confirms my views in his report of 120

cases treated by him in 1887. He regards it as a powerful adjuvant to hygenic measures, and especially commends it in incipient cases, but thinks it occasionally injurious where there is much erethism or high temperature. He states that "it stimulates the appetite, favors the nutritive processes, reduces the cough and builds up the general health, while locally it is an efficient disinfectant."

I do not wish to create the impression that I consider ichthyol a specific in any sense of the word. I find only that it has many qualities as an alterative and tonic with certain power to constringe engorged tissue by its action upon the capillaries, and in my judgment, alteratives and tonics are excellent means with which to combat the destructive tendency of tuberculosis. By means of improved digestion and assimilation we furnish the supplies necessary to the building up of good healthy tissues.

I regard it as a valuable adjunct to the tuberculin treatment to which I have given my steadfast adherence. In an article that I wrote a year or so ago as to the relative merits of toxins and antitoxins, I stated my belief that the toxins of the tubercle bacillus, or the watery extract of the tubercle bacilli produce in the body of the individual that personal antitoxin which is antagonistic to the growth and development of the tubercle bacilli, with corresponding increase in leucocytosis. It is evident that this warfare in the tissues demands the highest grade of nutrition. As to the physiological law of its action I am as yet in doubt. I use it empirically as we do the most of the medicines in our daily employ. It will have yet to undergo the crucible of the physiologist.

I have used it largely in cases of a haemorrhagic character on account of its power to constringe the capillaries in inflamed and congested tissues, as my observation is that it does not raise the blood pressure. I make constant and beneficial use of it in tuberculous ulcers of tissue and caries of bone. I have found that it is much superior to balsam Peru or iodoform. I first curette as thoroughly as possible and then pack the cavity with gauze saturated with the pure ichthyol. In laryngeal tuberculosis I have found its astringent properties of service, using it as a spray in a 10 per cent. solution. I have recently used a suspension of ichthyol in glymol with orthoform-new and am so far pleased with the result. The analgesic effect of the orthoform modifies greatly the pain and irritation that occasionally follows the use of the 10 per cent. watery spray. In cases of laryngeal ulceration from the softening and breaking down of tuberculous deposits I have found it of great service and, in fact, prefer it to glacial acetic or lactic acid. My favorite mode is to first curette and then apply with a cotton wrapped applicator, rubbing it well into the excavations. It is, of

course, necessary in doing such severe work to thoroughly anaesthetize the larynx. While I recognize fully the implacability of tuberculous degeneration of the larynx, yet I am glad to state that I succeeded better with this treatment than with any other, and have some very excellent cures or rather arrests to my credit.

I have administered it in combination with creosote plain or its carbonate, but after a considerable experience with this mode have reverted to the plan of giving it pure and simple. While its taste is acrid and very disagreeable, yet I find many who can take it dissolved in aerated water or milk. I much prefer, however, to give it in capsules except to the very young. I begin with a No. 2 capsule, which will hold about 10 minims. At the end of a week I increase to a No. 1 capsule, the third week I increase to a No. 0 capsule, which will contain about 20 minims. The sixth week I increase to the maximum dose of 50 to 60 minims, three times daily, given 30 to 40 minutes after taking food. By beginning with the smaller dose I avoid the disagreeable eructations that sometimes follow the administration of full doses too early. The full or maximum dose will, in a few cases, produce a slight diarrhoea which is of a transient nature and may be readily controlled by a few doses of dermatol. I have further noticed that in about 10 per cent. of the cases there comes on a peculiar bronzing of the skin, after two or three weeks use of the full doses, giving it a uniform coppery color, but this soon disappears, leaving the skin soft and clear with a disappearance of the acne eruption, noticed in the young adult. While I do not claim that the remedy has a specific effect upon the tuberculous deposits, the fact remains that the infiltration recedes with gradual clearing of the dull areas. The rationale of the matter, I presume, lies in the general molecular improvement of all the tissues with absorption of the inflammatory products.

I have tried various modes and methods of administration to get rid of the disagreeable smell and taste, but have found nothing better than the capsule taken on a full stomach. For the past year I have given largely the preparation known as *ichthoform* with most excellent results, as the powder is comparatively tasteless and it is claimed that it is broken up after reaching the alkaline juices of the duodenum, thus avoiding the disagreeable eructations. The only objection that I find to it in general practice is its excessive cost, as the dose to be effective, must be not less than 20 to 30 grains.

While I have collated freely from the writings and opinions of others my motive has been to attract attention to this most useful drug in the treatment of a condition that is to-day absorbing the attention of a majortiy of our profession. While I cannot, and do not, laud it as a

specific, yet I can conscientiously claim for it, after twenty-two years of careful observation and experience in the treatment of tubercuolus diseases, that it is, by far, the most useful drug that we have at our command. My notes and charts of over 600 cases cover a period of over fourteen years. I have had opportunity to follow a majority of the cases that have been discharged from my care as cured or improved, and am satisfied that the results have been more satisfactory with this line of medication than with any and all others I have tried.

I should perhaps have stated earlier, that the preparation of ichthyol to which I constantly refer in this paper is the sulpho-ichthyolate of ammonium, the chemical composition of which is given as C_{28} H_{36} S_3 O_6 $(NH_4)_2$. The chemical description of this and other forms of ichthyol may be readily referred to in any of Merck's recent publications.

THE DIAZO-REACTION: ITS VALUE AS A PROGNOSTIC SIGN IN PULMONARY TUBERCULOSIS.

BY CHAS. R UPSON, M. D., WATERBURY, CONN.

Essentials for the successful management and treatment of pulmonary tuberculosis are an early diagnosis of the disease—of which the patient should at once be advised—and the assurance of a favorable prognosis, even though our prognosis may in some cases present a double face—to be viewed on the one side by the patient and on the other by the patient's family.

Dr. Walker, writing most interestingly on the therapeutic value of prognosis, says:[1]—"The relationship of the physician to a patient and to a patient's family is wholly different. It is the physician's duty to give the most favorable prognosis possible to the patient as a part, and the initial part, of treatment. If he errs, let it always be towards the favorable side. To the family he may disclose his fears, and dwell more on the hazards of the illness, but to the patient it must be hope and assurance." To this might be added the proviso that in the physician's judgment the family is trustworthy.

The phthisio-therapeutist stands perhaps on a somewhat different plane from the general practitioner as regards his patient, in that he believes more firmly in the curability of the disease than do many of the "generalists." His verdict naturally carries greater weight in the

[1]Prognosis: Its Therapeutic Value. *Medical Record*, January 18, 1902.

minds of the patient and his family, hence the lung specialist must be prepared to give a more decided prognosis when required.

The diagnosis of tuberculosis no longer necessarily means to the intelligent physician an unfavorable prognosis. We know how confidently the consumptive, even in an advanced stage of the disease, views his own condition. It would seem that the more serious the case the more hopeful the patient. In many or most of these cases a conclusion is easily reached, but how shall we solve the prognostic problem in those cases less clearly marked?

In some cases of tuberculosis, even in the early stages, certain waste products are retained in the blood which in a healthy state are eliminated. While the retention of these substances may cause but few noticeable symptoms, they are productive, nevertheless, of certain changes in the patient's urine, readily detected by mean of the diazo reaction—discovered by Gries—which when found for a considerable period is indicative of a most unfavorable condition.

This reaction is not infrequently demonstrable in afebrile periods of tuberculosis and in cases where but few, if any, tubercle bacilli are to be found in the sputum. While the reaction may be marked in some cases even in the early stages of the disease, it may be altogether absent in other and more advanced cases.

We are indebted to Michaelis for much valuable information regarding the application of the diazo reaction to the prognosis of tuberculosis. In 1899 he published the results of his examinations of 106 cases. Of these, 75 presented positive, and 31 negative results. Of the positive cases none recovered, eight were somewhat improved and fifty-nine died. Of the negative cases, with the exception of two deaths and two cases in which there was no improvement, all the cases showed improvement, with two cases cured.

While it is true in rare instances that the reaction may under proper management and treatment disappear from the urine and the tuberculous patient regain his health, in the majority of cases, however, in which a decided diazo reaction is persistently present there is but slight hope of recovery.

Michaelis believes that patients exhibiting an intense diazo reaction should be excluded from tuberculosis sanatoria, as unfavorable cases for treatment, and Koch holds that such cases will not be benefited by the tuberculin treatment. Dr. Karl von Ruck thinks that the diazo reaction does not present a hopeless significance, especially in cases where in its absence the clinical prognosis would be different. In quite a number of instances in his practice where it was present and well marked, he has seen it disappear permanently under proper treatment

directed to the elimination of waste products through the kidneys, such cases having thereafter progressed as favorably as did others in which the reaction had never been observed. He believes, however, that a careful urine analysis should in all cases be made and when the urine shows the reaction persistently, regardless of the plentiful drinking of hot water or the use of mild diuretics, the prognosis may be considered bad.[1]

Dr. Wood, speaking before the New York Pathological Society on the prognostic value of the diazo reaction, said that observations had been made at St. Luke's Hospital with the diazo reaction in 230 cases. Of these patients, 190 were still living and had presented no diazo reaction. Ninety per cent. had presented absolutely no reaction at any time, while the remaining 10 per cent. had occasionally yielded a slight reaction. These results correspond very closely with those obtained in certain German sanatoria. Of the 52 patients who had died in the hospital, 75 per cent. had given a constant and strong reaction, and, if the persons dying from nephritis or haemorrhage before the process in the lungs had become advanced were eliminated, the percentage of fatal cases giving the diazo reaction was 90. Of those giving a strong reaction extending over several weeks, 40 were fatal within three months. They had noted some very strange fluctuations in the reaction. For example, it had been repeatedly observed that in damp or rainy weather a much larger proportion gave a diazo reaction. Any of the gallic-acid or tannic-acid preparations, as well as salol, creosote and phenol, would inhibit the reaction. No connection had been observed between the strength of the reaction and the elevation of the body temperature—in other words, the reaction seemed to indicate the extent of the tuberculous invasion of the lung rather than the amount of mixed infection.[2]

H. W. Syers, on the other hand, thinks the diazo reaction of but little prognostic value in "phthisis." He says:—"My experience of the diazo reaction in phthisis is not large, but I have had the opportunity of applying the test in very advanced cases of the disease. My results do not in any way agree with those which would mark the diazo reaction either as of usual occurence in the latter phases of the malady, or, when it does occur, as of being of any special significance. In ordinary cases of this description the result was negative, and when the reaction was positive there was no reason whatever to suppose that the

[1]Karl von Ruck. "The Prognosis of Pulmonary Tuberculosis." *Journal of Tuberculosis*, October, 1900.

[2]F. C. Wood. "A Note on the Prognostic Value of the Diazo Reaction." *Medical Record*, April 10, 1901.

case offered any special feature of gravity beyond that which is usual at the stage at which the affection had arrived."[1]

The results of my own investigations with the diazo reaction in tuberculosis have shown that it does not in every case indicate the extent of the tuberculous invasion of the lung, but depends upon some other condition of the system. I have in several cases in which there was comparatively slight lung involvement, obtained a decided and persistent reaction. In most of these cases the disease, in spite of energetic eliminative treatment, steadily progressed to a fatal termination. To my mind the diazo reaction when persistently present in a given case of tuberculosis is, even in the absence of other and more generally accepted evidence, of considerable value as an unfavorable prognostic sign.

TUBERCULIN OBTAINED FROM THE BOVINE TUBERCLE BACILLI CONTRASTED WITH TUBERCULIN OBTAINED FROM THE HUMAN TUBERCLE BACILLI, IN THEIR EFFECTS ON HUMAN PATIENTS.

PRELIMINARY PAPER.

BY CLEMENT A. PENROSE, M. D., BALTIMORE, MD.

At the request of the Editor of the *Journal of Tuberculosis*, I decided to publish the results of my investigations on the effects of tuberculin obtained from the bovine tubercle bacilli on human subjects, contrasted with those of tuberculin obtained from the human tubercle bacilli, as far as these experiments have gone.

Owing to the difficulty of obtaining suitable tuberculous cases, my progress has necessarily been slow. I published an announcement of this work August 24th, 1901, in the *British Medical Journal*, August 10th, 1901, in the *Philadelphia Medical Journal*, and August 10th, 1901, in the *Journal of the American Medical Association.* Since this announcement was made, there have been one or two vague publications on the subject of little scientific importance.

The address of Prof. Koch, July 23d, 1901, before the British Congress of Tuberculosis, gave rise throughout the world to much controversy concerning the identity of the tuberculosis of cattle with that of human beings. In this paper Prof. Koch gave no evidence of having covered in his investigations the field any more closely than had Dr. Theobold Smith, of Boston, as far back as 1898 in the July and September editions of the *Journal of Experimental Medicine*, a fact that we

[1]H. W. Syers, "The Diazo Reaction as a Method of Diagnosis in Clinical Medicine," *Brit. Med. Jour.*, May 24, 1902.

should, as Americans, be very proud of. Prof. Koch's deductions, however, even if we believe them erroneous, had a wonderfully stimulating effect on medical work in this direction, and perhaps, as has been suggested, were made somewhat for this purpose. While reading this address, the idea occurred to me that a very important experiment had been omitted, at least, no mention was made of it, namely, to contrast the products of the two bacilli or their tuberculins, in their effects on the same human subjects, a harmless, and yet important method of studying variations should they exist in the bacilli themselves. Knowing how difficult it was to be sure a pure culture of the bovine bacilli was obtained, I wrote directly to Dr. Theobold Smith, who most kindly sent me cultures of the bovine as well as of the human tubercle bacilli, from which through the courtesy of Parke, Davis & Co., two very excellent tuberculins were prepared. These tuberculins were made by identically the same process as are the other tuberculins placed on the market, and were contrasted in several instances with tuberculin obtained from Dr. Trudeau's laboratory, which proved them to be up to the mark in every respect. At present these tuberculins are being tested on surgical cases in the wards of the Johns Hopkins Hospital through the kindness of Dr. Halsted, and careful records kept of their reaction, effects, and so forth.

As yet, only a few cases have been tested, which, however, have given very suggestive results. In this article I exhibit the charts of one case which was tested, first with Trudeau's tuberculin, then with my human tuberculin, and then with my bovine tuberculin.

The case, William B., negro, aged twenty-two, was admitted to the hospital April 14th, 1902, with tuberculosis of the left wrist joint and a tuberculous abscess over the dorsum of the left foot. Otherwise he was fairly healthy; the chest and heart were negative. From the accompanying chart it will be seen that in both instances a typical tuberculous reaction was obtained, but in the case of the bovine tuberculin the reaction was more marked, the acme reached one hour sooner, and then the temperature fell to 99 degrees, where it remained for some time. In other words, a more decided reaction was given by the bovine tuberculin than the human tuberculin, although used several days later, and in a subject who had had during this time hospital diet and treatment.

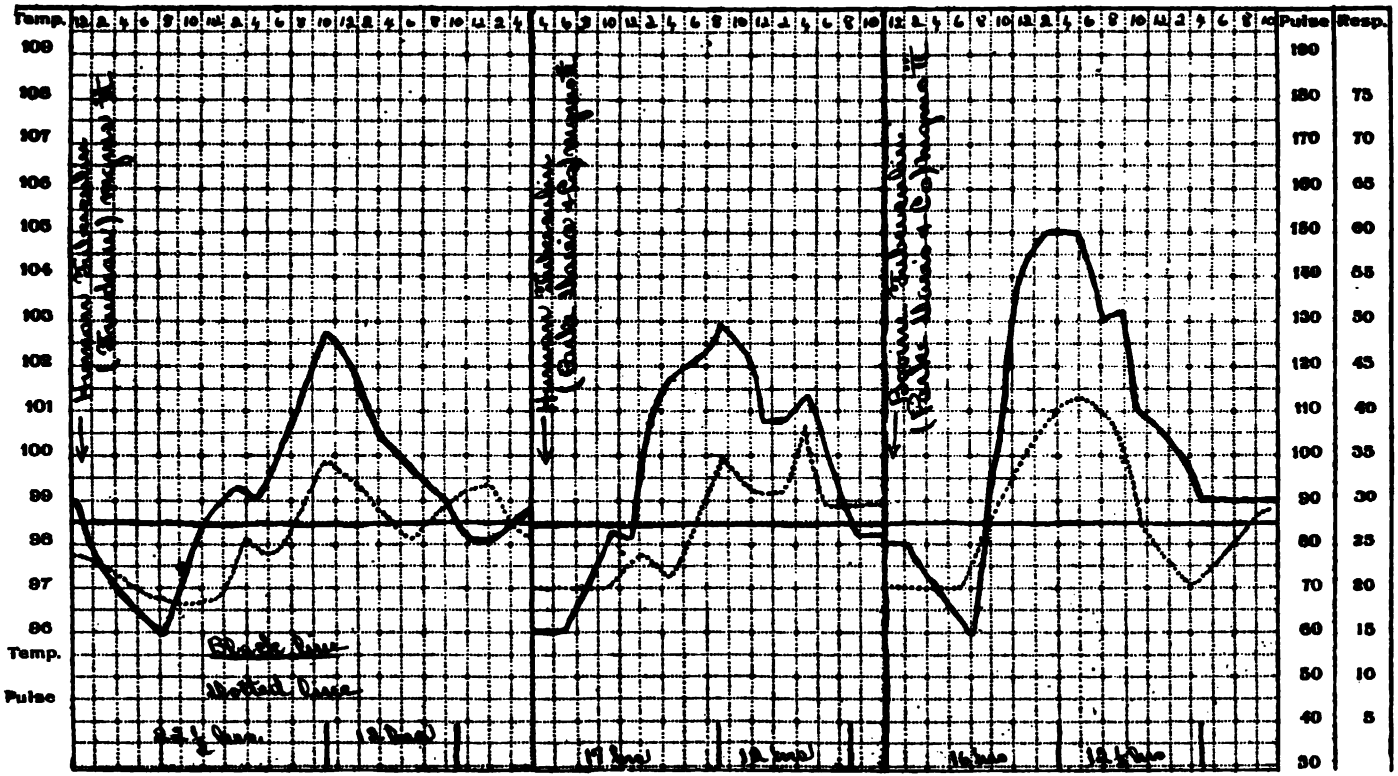
I believe from this and other cases, it will be shown that, first, the bovine tuberculin positively gives a reaction in human tuberculous patients; second, that this reaction is more active than that obtained from the human tuberculin, evidenced by a higher temperature and a later return to the normal temperature.

Conclusion: The products, or tuberculins of the bovine and human tubercle bacilli seem to be identical in their effects on human

THE JOHNS HOPKINS HOSPITAL

No. 38581. Admitted April 14th, 1902. Ward M.

A.M. April 17th. A.M. April 24th. A.M. April 28th.



Human (Trudeau) Human (P. D. & Co.) Bovine (P. D. & Co.)

tuberculous subjects. The bovine tuberculin appears to be the stronger, suggesting that the bacilli themeselves are identical, but the bovine bacilli more virulent.

It will be interesting to test these two tuberculins on tuberculous cattle and note their effects. It is hoped that the opportunity of making such contrast may be afforded.

THE ETIOLOGY OF THE INDUCTIVE AND INCIPIENT STAGES OF PULMONARY TUBERCULOSIS AND SPECIFIC TREATMENT BASED THEREON.*

BY THOMAS NEIL MCLEAN, M. D., ELIZABETH, N. J.

In the consideration of the etiology of tuberculosis it will be well for us to bear in mind that impressive couplet of Sir John Davis, the truth of which I think we will all admit:—"Skill comes so slow, and life so fast doth fly. We learn so little and forget so much."

The etiology cannot be properly considered without reverting to some of the physiological principles and facts upon which alone a successful treatment may be based, and thus, as Austin Flint once said, to "harmonize the indications of nature and science in accordance with the dictates of common sense."

You will bear with me then, "lest we forget," while I refer briefly to some of the salient points. I am indebted to Simon H. Gage[1] for some of the points here mentioned.

There is no function of the human body more essentially *vital,* than that of respiration. It is a *sine-qua-non* of human existence, and there is no process or function of the body, the *incompleteness* of which, with, or without organic change, is more prolific in the production of disease. The process of respiration is distinctly *nutrient* in one of its most important phases.

The nutrition of the body depends not only upon a proper supply of solid and liquid pabulum through the stomach, but also upon a sufficient supply of gaseous pabulum through the lungs; and the degree of health and vigor depends upon the quality and quantity furnished to the tissues through these two receptive organs.

Few in this land of plenty starve to death for want of food in the stomach, but hundreds of thousands are starved to death through lack of oxygen, the gaseous pabulum of the tissues which is introduced by way of the lungs. Man may live for a considerable period without food by

*Read at the American Congress of Tuberculosis in New York City, June 3, 1902.

[1] *The Reference Handbook of the Medical Sciences.*

the stomach, but the demand for oxygen is *constant and imperative.* The blood is the carrier of nutrition to all parts of the body, and must be constantly renewed with those elements which support the growth, development, and sustenance of the tissues. The entire volume of blood must pass through the lungs once in every three to five minutes, for its necessary supply of oxygen and elimination of carbonic dioxide. The change from venous to arterial blood may be complete or incomplete. The completeness of the change is not due to differences in the constitution of the atmosphere at different places and times, for the variation is found to be trifling, so that the cause of incomplete arterialization is to be found, not in the gaseous food, but in the organs in which it is to be digested.

We find that the *digestion* of air in the lungs is accomplished by an almost complete contact with the blood, the alveolar walls alone intervening, through which, in accordance with the well-known law of physics, the gaseous oxygen passes from the alveoli into the blood and, uniting with the plasma and haemoglobin, forms oxyhaemoglobin, or bright arterial blood, while at the same time, the carbonic oxide passes from the blood into the alveoli. The *rapidity* with which the interchange takes place depends upon the tension of the alveoli, which is produced by the pressure of the gases therein. If the pressure is low the interchange will be correspondingly slow, and the nutrition of the blood and tissues will be adequate or inadequate, corresponding to the degree of alveolar tension. Besides the process of nutrition by oxygen, the elimination of excrementitious gas or carbonic oxide is *stimulated* by a plentiful supply of oxygen. If the elimination of the excrementitious gas through the lungs is deficient, general lassitude and impairment of gastric digestion follows, through poisoning of the nervous centres, with relaxation of the capillary circulation in the skin. The amount of interchange of the gases in the tissues remote from the lungs, depends upon the amount of oxygen in the plasma and haemoglobin which has been received in the act of respiration and conveyed in the capillaries to its ultimate destination. If the supply of oxygen is small the tissues farthest from the central organs of supply are the first to become livid—a state of true asphyxiation. The healthy adult man, according to Pettinkofer and Voit, takes up in twenty-four hours, seven hundred and fifty grams of oxygen and excretes nine hundred grams of carbonic oxide. The same investigators have shown that the interchange depends largely upon bodily activity. The hunger for oxygen does not come primarily from the lungs themselves, but from all the tissues of the body. Let an individual having a normal chest action breathe deeply and quickly, and he will be able to cease breath-

ing for a longer period than he would otherwise be able to do. This shows that the interchange of the gases has been increased by the deep breathing, so that, for a time, the demand is less urgent, because the haemoglobin and plasma are in a state approaching saturation with oxygen, and as we have already seen the rapidity of interchange depends upon the tension of the alveoli. This is our first and most important conclusion in the operation of a natural law which we are to apply in our diagnosis and treatment of the inductive stage—the so-called "suitable soil." I consider the complete vesicular murmur to be the criterion of perfect pulmonary function and organic health, and to be as valuable as a diagnostic sign as all the other physical signs put together.

When from any cause whatever except emphysema, the function of respiration is incomplete, as evidenced by the absence or muffling of the vesicular murmur, we have the positive evidence of insufficient alveolar tension, the prime cause of a departure from health. I believe that the surest way to keep an organ in perfect health is to keep it in perfect function, and that in the case of the lungs, an incomplete function *must necessarily* be followed by organic disease. Robin's recent investigations as to the increased rate of gaseous interchange in the offspring of tuberculous parents, and in the acquired disease, have a deep significance, entirely in harmony with the physiological processes and practical observation. Robin has done the profession a valuable service in proving and announcing the fact, but, as I believe, he errs in his interpretation and application of the fact.

I cannot agree with him in his conclusion that the increase of interchange is a positive destructive process, and one which should be restrained by rest and medication, but I believe that it is a conservative process of nature in its efforts to maintain the integrity of the tissues, and should be helped rather than hindered. I agree with Robin in the conclusion, that in the non-tuberculous "such increased gaseous interchange is an indication of a favorable soil" for the implantation of the bacillus, but I cannot accept without more reasonable proof, that the systems of such people "receive too much oxygen and produce too much carbonic oxide." In fact, I believe that it is by this means that nature is able to cure, according to the statistics of Nageli of Zurich, over 90 per cent. of all the cases of pulmonary tuberculosis without the aid of the physician. With the loss of alveolar tension, there is not only a decrease in the gaseous interchange in that portion of the lungs so affected, but also a retarding of the blood currents.

Any reduction of the elasticity of the lungs interferes with the circulation of the blood in them, whether it be as a result of inflammation, loss of vaso-motor control, traumatism, or of the external interference

with the expansion of the chest, as by tight clothing, cicatrices from extensive burns and scalds of the chest, occupations which compel the muscles of respiration to weaken for want of use, thus favoring blood stasis and consequent infiltration and proliferation of cell elements, and serves to produce what we may properly call the inductive stage or suitable soil in which tuberculous infection is not only possible, but highly probable. In emphysema, *alveolar tension* becomes *alveolar distension* without the power of contraction, and here the vesicular murmur is lost.

Abrams, in his recent admirable study of pulmonary disease with the Roentgen rays, says: "As a rule this lung emphysema in phthisis is limited to the lower lobes, and is dependent on the fact, that the air in entering the pulmonary tree, travels in the direction of least resistance." I believe that the emphysema in the lower lobes is the result of the efforts of nature to compensate the deficiency in the upper lobes, and is secondary thereto, and it is during this compensating process that we get the increased gaseous interchange of Robin, and, going still further, the microscope proves that in the first stages the red blood corpuscles, leucocytes and haemoglobin are kept up to the normal percentage, until, by the overwhelming disturbances of the later stages, a true anaemia supervenes.

To recognize the evidences of the inductive stage of tuberculosis, then, is of the utmost importance, because, as I believe, a case is lost or won at the beginning of treatment rather than at the end. The recognition depends absolutely upon the care and assiduity which the physician brings to the examination, and he should ever be upon the alert in his daily round of practice to discover the evidences of predisposition. In this stage the microscope furnishes no assistance. The Roentgen rays are as far away as the moon to thousands of physicians and in this stage would be of little avail, but if the ear catches the sound of the true vesicular murmur, as the evidence of alveolar tension with its consequent results in the healthy chest, he may be able to diagnose the muffling and suppression of that murmur which is a positive proof of an imperfect function, which, unrelieved, constitutes the inductive stage, also called the suitable soil for the propagation of the bacillus.

Having recognized the conditions of this stage, and appreciating their far-reaching import, it is our duty to apply ourselves *at once* to the restoration of the impaired function. How can this be done? By the administration of drugs? Positively no! But by means which Nature herself approves and to a limited extent supplies. Our advice to such a patient should be just as exact and specific, and as much or more care exercised than in the prescribing of therapeutic drugs. To

say to such a patient, change your occupation, live out of doors, go to the mountains, may in many cases bring about the desired restoration. Good as this advice may be, I consider it a shotgun prescription, because, although it may succeed, there are many chances of failure which should be eliminated; first through an appreciation of the exact conditions of *imperfect function*, and second, through the knowledge of the fact that the *function although involuntary* is also *voluntary*. Nature has this function of respiration under the control of the will, and thereby furnishes an exact or specific course to follow, which does not necessarily require a change of occupation, methods of living, or place of residence, although these are of very great value.

My experience of thirty years has taught me two specific exercises which the patient must assiduously practice in the restoration of the normal expansion, which restores the normal alveolar tension. These are as follows:

First, the exercise in imitation of the cough, which should be performed at any time or place, except in a cold dusty wind or in a dusty room, and in any position of the body. It consists in the inhalation through a chink of the lips, about the size of a common lead pencil, slowly and steadily, until the lungs are filled to their utmost capacity, at which time the lips are tightly closed and the cheeks bulged forcefully, which prevents the escape of the air by the nose. The inspired air is then held until the excess of blood in the lungs is driven out into the general circulation, as indicated by a sense of fullness in the forehead. This sensation is a positive proof that the patient has accomplished the act successfully and requistely. Considering the fact that the patient breathes at the rate of eighteen to twenty times per minute, he should perform the exercise as many hundred times a day, as it is possible to think of it, or *until the complete voluntary becomes a complete involuntary act.*

The advice often given to go out in the morning, and take long breaths, is very inexplicit, and is followed by no definite results. This exact method of breathing which I have described, or any other which can be proved to be equally as good should be taught, and the practice of it insisted upon, throughout all the waking hours. When the muscles of respiration have become weakened, this method may be found insufficient to accomplish the purpose alone, and we must resort to another method which is also indicated by nature, and often witnessed as an involuntary act, on the part of a tired individual.

The second method, which I call the stretching or yawning exercise, is performed like the first, but with the addition of elevating the hands and arms to a nearly perpendicular line above the head, and is

best performed in the standing position, or while reclining with the hands clasped on the top of the head. At the commencement of the inspiration in the standing position, the arms are thrown up quickly above the head, one hand clasping the thumb of the other, until the chest is fully inflated, and then quickly dropped, the arms and hands resting their weight upon the front of the chest. A much larger amount of air can be inspired by this method, but cannot be held as long as by the first method, the proof of the success of the act coming much quicker.

I have found no other voluntary methods so successful as these, because these exercises do not quicken the heart's action, but rather retard it during inspiration. While the breath is being held, the same effect is produced in the alveolar tissue as that of an altitude of several thousand feet, so that by this method we bring the mountains to the patient instead of sending the patient to the mountains. If the case has progressed so far, before rational treatment is begun, that these two methods are found insufficient on account of weakness of the muscles of respiration, then promptly resort to pneumatic differentiation by altitude, or in the home treatment by the pneumatic cabinet, when it can be obtained. The principles of pneumatic differentiation although approved by many of the best men in the profession, have never been put into practical service by the mass of the profession, on account of the expense of the cabinet.

If the patient's condition has gone on to the stage of exudation, either inter-pulmonary as in choked apices, or inter-pleural with plastic lymph, or bronchial with cough and expectoration and hemoptysis, all of which results from excessive blood pressure, being out of proportion of the air pressure in the lungs, these methods properly carried out, check the process of exudation, and stimulate the lymphatics to remove the debris, and prevent agglutination of the pleural surfaces. If hemoptysis occur, I assert positively that there is no other way besides forced expansion by which this symptom can be permanently prevented. Vaughn claims that in hemoptysis ninety-nine cases out of one hundred are tuberculous. By reëstablishing a permanent equilibrium of blood and air in the lungs, the integrity of the blood vessels and tissues is maintained and tuberculization checked in its spread. The first indication in hemoptysis is rest in the semirecumbent or sitting positions; then reducton of the force of the heart's action, if turbulent, with high tension of arteries, by aconite, quieting the fears and assuring the mind of the patient; then, when fresh blood has ceased to be expectorated, the patient should be instructed to expand his chest gently by the first method, gradually increasing, until be is able to per-

form the second method, with sufficient force to bring about the requisite equilibrium. If atelectasis has occurred, there is no other sure way of opening up the choked bronchi, and reëstablishing the air and blood currents in the collapsed lobules.

After the investigations of the respiratory system by Hutchinson and others, which promised great results in treatment, the whole matter was, through a *misconception*, relegated to the domain of Hygeia or sanitary science, where the majority of the profession have allowed it to remain until the present time, thereby failing to reap the success which should have been theirs.

Very much has been written during the past twenty years in regard to pure air, and the ventilation of workshops, offices, living and sleeping rooms, so that I need to say nothing in regard to this, but to insist that *confined air once breathed is a poisoned air.* I would all the more strenuously insist, that the *perfect ventilation* of the *lungs* is of *infinitely greater importance,* than the ventilation of rooms, as a prophylactic against organic disease. What does it avail, however pure the air may be, *if it is barred out of the pulmonary structure,* either in part or whole, *so that the gaseous interchange cannot take place in the ultimate cells?* Is there a single capillary bronchus, or a single air cell in the entire structure, which was *not* intended to receive air and assist in the aeration of the blood? No. These tissues are made not only to receive, but also, by the expansion and contraction of the cell walls, to continuously further the interchange of the gases, whereby the blood and tissues may have their vitalizing pabulum in sufficient quantity to maintain the conditions of health. Stagnation in the lungs is a pathologic condition, and means disease and death. The only physiologic rest for the lungs, is a complete function, and any other application of the term *rest,* as applied to the lungs, is a misnomer, for which the term *suspended function* is more appropriate.

When in consequence of the imperfect mechanical function of the lungs, the interchange of gases is retarded, a chain of symptoms presents itself, which we all recognize as suspicious evidence of tuberculous infection, either impending or already existent. These symptoms are a loss of weight, a throaty voice, pseudo-anaemia, tachycardia, which is the result either of essential weakness of the heart walls themselves or of the necessity put upon the heart to contract either with greater force or rapidity in order to overcome the obstructions to the flow of blood consequent upon the loss of pulmonary elasticity which is an important aid in its propulsion. Other signs are anorexia, a higher pitch of the percussion note, diminished expansion of the chest as shown by measurement with the tape line, slight afternoon rise of

temperature, prolonged expiration from narrowing of bronchi, the "gravitation" cough upon reclining, and as the disease progresses, many other symptoms which are not seen in the inductive and primary infective stage, and which we are not now to consider. This part of my subject comprehends that of early recognition, and widens the field of hygiene in its most important direction.

Infection by the tubercle bacillus is only possible when the soil is prepared for it.

The only sure pulmonary prophylaxis is by the natural method as I have decribed, putting every cell and tube and capillary blood vessel in perfect function, thus preventing stasis, either of blood or air, and leaving no quiet resting place for this germ to locate and grow. The same treatment applies when infection has taken place, for the purpose of protecting the non-infected areas, as in the inductive stage.

The impossibility of germicides, taken by the stomach, reaching the infected tissues in sufficient strength through the blood currents to be of any avail, is the conclusion of the entire profession. Creosote and its congeners, are of considerable value when associated with the methods of expansion, in ameliorating the cough and relieving bronchial irritation.

I cannot delay you with reiterations, however strong or important, but my plea is that the profession, whose attention for the past ten years has been so absorbed by the bacillus and in the search after the means for its destruction, would turn its attention to the plain physiological principles which I am trying to enunciate. By so doing I believe it would turn from the prevalent method of medicating tuberculous patients, to the method of nature, which will bring a larger meed of success than any other method now known—a method, which, in the inductive stage, will absolutely prevent infection, and which in the primary infective stage, (the limit of which is mixed infection) will protect tissue not already infected and in a majority of cases clear up the infected areas.

It is not to be thought for a moment, that this can be done without regard to the nutrition of the body, by the solid and liquid foods through the stomach, *for the gist of the whole matter is food, gaseous, solid, and liquid, received in proper quality and quantity, and thoroughly digested in the receptive organs.*

In addition to the above in the treatment of either stage, cold water bathing with friction is an important aid not only in invigorating the muscular system, but also in stimulating the respiratory nerve center in the medulla, and should be practiced daily.

The therapeutic indications for ichthyol, creosote, chloride of ammonium, strychnia, hypophosphites, etc., are not to be disregarded, but the patient must be impressed with the idea, *that these are of minor importance*, and that the taking of the drug, however faithfully, *if unaccompanied by expansion*, will be most likely to result in failure.

The effects of deficient pulmonary expansion are found not only in the alveoli and convective tubes, but also in the terminal ramifications of the pulmonary artery. Infarction and consequent thrombosis, with softening and cavitation, also furnishes the suitable soil for the bacillary infection.

A proper alveolar tension is required to maintain the integrity of the blood vessels in the lungs, and assists in the propulsion of the blood stream. When the residual air pressure is below normal, and the right heart strong, we will find the first sound of the heart accentuated, indicating a laboring heart, also we may have its impulse stamped upon the inspiration, as manifested by the cogwheel rythm; this symptom is easily removed by expansion, which explains its causation.

From this physiological standpoint, natural immunity is *not* an unknown quantity. Natural immunity consists in the absence of those conditions which are necessary for the existence of the bacillus—that immunity which is found in the perfection of the pulmonary functions —and it is by this means only that hereditary vulnerability may be resisted, and acquired predisposition prevented. The so-called resisting power is thus reduced to definite proportions and brought up to a normal standard by exact methods.

Smothered by a chain of social conventionalism, our women, wearing tight clothing about the waist, are literally "dressed to kill," and beget a race of weak chested offspring, while the fathers by thousands, are of necessity obliged to be shut up in offices and shops, engaged in those sedentary pursuits which paralyze the muscles of respiration. In the first instance large areas of lung tissue are asphyxiated by direct pressure, and in the other smothered by apathy, a direct result of a physically indolent life. These conditions being ever present our profession must necessarily be alive to the exigencies of the times, and, with an acute ear and cultivated senses, be alert to discover the inductive stage as well as the incipient, and thus by rational treatment remove the patient from the dangers of the later stages. I claim that the inductive stage, or as it is called, the suitable soil for the propagation of the tubercle bacillus in the lungs, consists essentially and primarily in *conditions referable to the lungs themselves*, rather than to any general depravity of the entire system, as indicated by anaemia or spanaemia, or the antarthitic diathesis, or scrofula. Dyce Duckworth says: "Many per-

sons are scrofulous all their lives and yet never become tuberculized." Malnutrition has been claimed as the prime cause, but that very malnutrition depends upon deficiency in that last stage of food preparation, before it enters the arterial system, viz.:—oxygenation, and until that function is adequately performed, we can make no permanent headway in feeding, no matter how we may stuff.

By air, water and food the body is nourished. On this tripod the body stands. Knock away any one of these supports, and disease and death are sure to come.

In conclusion let me say that it is *important* that we base our therapeutic facts upon, physiologically exact, etiologic conceptions, rather than upon the practice of general hygiene to the exclusion of pulmonary hygiene, or any blind empiricism, no matter how classical or scholastically orthodox.

If our conceptions are based upon *physiological truth* as a starting point, we may arrive at the truth as to specific physiological error, as in the pathology and treatment of pulmonary tuberculosis, and in no other way will we succeed in the treatment of this disease, but in the way and manner which nature herself dictates.

ORIGINAL TRANSLATION.

ON IMMUNITY AND PREDISPOSITION WITH ESPECIAL REFERENCE TO TUBERCULOSIS.*

BY PROF. DR. P. BAUMGARTEN, TUEBINGEN.

Gentlemen:—Ideals are unattainable, but as goals they give a direction to our endeavors. We may hardly dare to hope that the art of healing will ever become superfluous in the field of medicine, but we may strive to reduce it to narrow boundaries through the prevention of disease. The profession has ever had this end in view, and during the last century its efforts have been rewarded by notable success, and by considerable gains even in the past decade. Since we have learned to recognize bacteria as the causes of many diseases and as exciting factors in many others, hygiene has taught us to keep these causes far from our persons, as for instance, plague, cholera, etc. When the disease-producing organisms cannot be kept in abeyance, as is absolutely the case in many diseases, then it is but rarely possible for the natural protective agencies, such as the squamous epithelium, ciliated epithelium, reflex actions, gastric functions, etc., to prevent invasion and development of bacteria in the organism. But Nature herself affords a certain immunity in many such diseases; she protects the organism through the act of immunization. Certain infectious diseases are but rarely contracted a second time. Such immunity, however, can be regarded only as a sort of Dänae gift, since it is acquired at the price of going through one attack of the disease. Much more precious, because safe and certain alike, is that immunity which protects us from one of the most deadly diseases by preventive inoculation with a substance closely related to the true virus of the disease, but so modified as to cause affections of a mild type analogous to those from which we would protect ourselves. In recent times bacilli of weakened virulence and vaccines obtained from organs which have been attacked by bacilli, have both been successfully applied as protective means (anthrax). These resources were followed by others, involving the discovery of protective substances which could not indeed shield the individual from infection for the whole or a greater part of his life, but which had the advantage of arresting infectious processes after they had once developed. Although no rational explanation of this latter phenomenon is as yet possible, a theory has been evolved, supported by continuous experimentation, which

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has accomplished more by arousing the admiration of the scientific world, than by exciting the gratitude of the public which has been the gainer by this line of research. Immunities are either naturally or artificially acquired; immunity through immunization. In addition to these, however, there is an inborn immunity, which, it seems to me, is referable to a different principle concerning which we are also still in the dark. It is an undisputed fact that entire natural orders, genera and species, yes, even mere varieties of animals possess from their birth a certain quality by virtue of which they cannot contract either naturally or by inoculation, certain diseases of bacterial origin, the latter varying with the kind of animal. Even mankind enjoys an inborn immunity to a number of diseases. This negative quality has been explained from different sides through the supposition of a destructive principle. In regard to inborn toxin-immunity, which does not coincide with inborn bacterial immunity, the view which has won credit thus far is as follows:—The poison is not rendered harmless because it is destroyed or neutralized by an antitoxin, but because it cannot establish relation, either temporarily or permanently, with the tissue cells of the body. Against the bacteria themselves, it is supposd that the body is protected by an inherent bactericidal substance through the immediate destructive effect of which upon the bacteria, the organism is protected. In particular has the ingenious phagocyte-theory of Metschnikoff gained wide acceptance, sustained as it is by a comprehensive observation of nature. The white corpusles, phylogenetic relatives of the amoebae seek out the substance of living vegetable organisms and take up and digest it. The theory in question assumes that this power may be imitated in the interior of highly developed animal organisms. If a hostile bacterium succeeds in penetrating into the human body and in proliferating therein, the leucocytes, while powerless to heal the lesion thus produced, may nevertheless fullfil a condition necessary to healing by destroying the bacteria. If they are in position to destroy the latter at the time of invasion, they add the power of cure to that of protection. If the latter power is completely developed, the animal may be said to be immune. *Vice versa*, wherever this immunity is encountered it has been conferred by prompt phagocytosis. Thus far, we have no satisfactory proofs that the bacteria which are found dead within the leucocytes were living when they were first incorporated, because these corpuscles may take up dead bacteria and inorganic substances. On the other hand, it is evident that the leucocytes form a favorable culture-medium for the propagation of bacteria. One might well believe that if the bacteria die they are incorporated within the leucocytes,

but if they enter the latter alive they have a good prospect of favoring general infection. It would be a very singular thing if immunity could be ascribed to phagocytosis; for if the body were inoculated by bacteria in large numbers some of the microörganisms would certainly get past their enemies, the white corpuscles, and cause general infection. Moreover, the fact that certain species and varieties of animals are specifically immune to certain bacterial diseases, whereas certain other animals which also possess like phagocytes are not protected against these diseases is a convincing contradiction to the theory of immunity through phagocytosis. For this reason the theory that the blood cells are bacterial destroyers has generally been given up, and their secretions or this or that still unknown substance of the circulating fluids were believed to possess bactericidal properties. If it could be shown that the blood or its serum was in itself directly bactericidal, the fact of inborn immunity would be readily explained. It appears to be a fact that blood from the veins does actually possess this property, because bacteria in many instances cannot survive therein. From my own studies in this field I can only state that a momentary arrest of development occurs under these cicumstances; and even this was absent when I introduced into the blood the merest quantity of true nutrient substance, and bacteria were then even able to proliferate abundantly in this alleged bactericidal medium. Not only one but many varieties of microörganisms were able to flourish in blood thus treated. The alleged bactericidal action of rabbit serum towards the anthrax bacillus disappeared after addition of 1 per cent. pepton and 1 per cent. sugar; toward the typhoid bacillus when 2 per cent. saltpetre was added, toward the cholera bacillus when 2 per cent. soda-salt-pepton was added; and after such additions this serum became an excellent culture-medium for the germs in question. Should we assume that venesection-serum necessarily contains bactericidal substances, we could not conclude forthwith that the latter are also present in circulating blood (attempts in solving this problem must be regarded so far as failures). In any case we need have no scruples in abandoning the view that inborn immunity resides in the blood; for even in cases where the latter appears to be bactericidal, the particular species of animal does not necessarily possess immunity to the attacks of the bacillus in question. Thus, although the anthrax bacillus dies when introduced into rabbit serum, the rabbit itself is highly susceptible to anthrax. On the other hand, this bacillus flourishes excellently in the venesection-serum of the dog, yet this animal is almost immune to anthrax. It is evident that we must look elsewhere for an explanation of inborn immunity. That any organism is unable to live and thrive does not necessarily imply that

something kills it outright, and so for the bacteria, it is sufficient to cause their death spontaneously if they do not find the conditions essential for their life and development. This simple explanation—perhaps too simple to receive the acceptance of some scientists who can be satisfied only by complex and ingenious methods—has nevertheless given definite direction to the further study of immunity, aided by the results which newer methods of examination have developed.

Now, gentlemen! Permit me to go more into detail.

The various cells of the animal and of the human body, differing as they do in form and function, sprang from one and the same mother-cell, and do not belie their common origin; they all remain subject to certain common laws of cell-life. Nevertheless, in their differentiation into organs of different function, a difference in the protoplasm which sustains the function must take place, and this protoplasm must be constantly renewed from the accessible circulating fluids. Whosoever brings much, brings something to somebody; especially that which each cell needs and can appropriate, it does actually select, not from voluntary power of choice, but because of the ability of the receptor of the lateral chain of its protoplasm to anchor a corresponding uncombined atom in the nutrient substance from the circulating fluid, according to the principles of chemical affinity. Every cell does not anchor every possible form of nutrient material; the receptor of one does, that of another does not, each according to its specific needs. Proper receptors and receptible nutrient material are the conditions of life for every cell, and this method of representing physiological processes of nutrition has a firm support in recent toxicological study.

These relations obtain in the unified complexity which represents a tissue-cell. Let us next turn to bacteria. I believe that I stand in entire accord with the principles of the doctrine of evolution and descent—which are doubtless also recognized by you—when I state that the family of bacteria has been differentiated from a common ancestor, just as have the numerous cells of the animal body from a single cellular formation. While the latter has been able to build up a solid individual by the coherence of the cells, the different bacterial cells are able to pursue an existence in which they are entirely independent of one another. Although differentiated, the bacteria will probably always require intermediary receptors for their nutrition, and because they are differentiated they require a nutrient material for which the individual receptor has an affinity, and this nutrient material is not the same for all and is not applicable to all in the same manner or in the same degree. While in a general way it may be said that bacteria make but simple demands

for their nutrition, this is only true in so far as under certain circumstances a simple mixture of organic substances suffices for them. But simplicity in demand is not indifference, because by nature they are thoroughly selective. While some prefer simple mixtures others choose organic combinations in the dead state, upon which alone they can thrive in nature; still others select matter for food which is in the full activity of life (obligative parasites). Some of this latter class thrive best upon a particular species of animal and may even depend upon a particular quality of that species, whether resident in the blood or in the tissues. We are not justified in denying the requirement of specific character of nutrient material because we find no chemical differences in the blood of different species of animals. In the chemical laboratory like bodies are not biologically equivalent. When the blood is removed from the living body its components undergo a secession; in their organic combination during life the degrees of reaction differ although they are apparently alike after death. In the degrees of reaction is also expressed that which differentiates species from species, surely to a greater extent than the simple color of the hair or the length of the tail.

Whenever we find that certain bacteria thrive exclusively in a single species, we are forced to say that here and not elsewhere can the receptor, in the creature which makes possible its nourishment, find its anchoring substance; and vice versa when it cannot secure this anchorage, the bacterial cell cannot proliferate; and when it cannot proliferate, it cannot infect. Such animals are therefore born immune; and for them to be born immune it is not necessary that their tissues shall possess bactericidal properties. Such is my understanding when I say that the inborn immunity has its foundation therein, that in the animal or in the man the conditions essential to the growth of the particular bacterium are not present.

When we succeed in gradually developing a bacterium upon a given medium into a state which does not occur in nature, or again in an animal in which it cannot thrive spontaneously, it could not well be assumed that its ability to thrive under new circumstances depends upon the withdrawal of bactericidal substances from the medium. Instead, this is due to the wide range of accommodation of bacteria, that is to say, to an ability of the receptor of the hungering cell to accustom itself to take up that to which, in its past life in its natural state, it had but slight relation, and through which accommodation this slight relation has been increased and developed by practice. The artificially developed bacteriolysis in which, through previous treatment of the animal, its serum acquires bactericidal properties, would speak rather for than against the

proposition that the inborn immunity depends upon another basis than does the acquired.

Here I should allude briefly to the astonishment recently excited by observations which go to show that the bacillus of human tuberculosis cannot be inoculated into cattle, and *vice versa*. According to this, the cow is born immune to human tuberculosis. But according to all our previous knowledge there is little doubt of the original identity of the two bacilli. The same bacillus, growing upon two different nutrient media, has developed into two species or at least into two varieties. It is readily intelligible that since the bacillus of human tuberculosis has been propagated upon one medium for hundreds of generations, it has become confirmed in a particular method of nutrition. The cow is therefore immune to its attacks, and *vice versa*. It is unreasonable to hold that this sort of immunity can depend upon the presence of some bactericidal substance which can destroy one germ without affecting the other; nor can it be stated positively that upon a common medium, these two varieties could not be made to return to a common type.

If now beyond the aforementioned immunity or disposition of the species and races there exists also an individual immunity and disposition is still an open question. This question has been debated with especial zeal in the domain of human tuberculosis, and it has been accepted that here indeed there is an individual disposition and immunity. As a proof for the acceptance of this proposition, its advocates have supported themselves by the observation that only a certain and comparatively small proportion of the human race acquires tuberculosis, while by far the greater proportion remains free from the disease during the entire period of its individual lives. Today the belief in a "tuberculous disposition" as a factor in the contraction has taken firm root, especially among practicing physicians. So long as the cause of tuberculosis was unknown and one was, therefore, inclined to look upon the disease as the expression of a constitutional anomaly or a peculiar weakness of the tissues, the "tuberculous disposition," and the hypothetical and true causes of the disease were considered as one and the same thing. It was necessary only to add an external exciting cause in the form of any inflammatory irritation in order to develop and bring into existence the tuberculous process in the diseased tissues. But we know now that the exciting cause of the latter is solely a specific endogenous parasite, and with this discovery the old idea of a predisposition has lost its practical bearing and must at least undergo modification, in order that we may profitably study the natural relations between parasite and host. Experience has taught us that Koch's bacillus is parasitic to all warm-blooded animals, although not in the same degree. That the *species*

homo is not only receptive in a general way, but especially so, is evident from the fact that no other species, with perhaps the exception of the bovine, pays so high a tribute in instances of disease and death, as does the human race. But even with this susceptibility only one seventh of mankind dies from the disease and not more than a fourth, or a third at most, becomes infected. Two-thirds of mankind, therefore, remain quite free from a trace of tuberculosis throughout their lives. Are we then to conclude that one-third of mankind is susceptible and two-thirds insusceptible to infection with the tubercle bacillus? Many are inclined to give a strictly affirmative answer to this proposition and but few would absolutely deny it. I, for my part, am unable to see in the limitation of the development of tuberculosis, as related, a proof of the existence of an individual disposition. On the contrary, I believe that all mankind is predisposed to tuberculosis, that is to say, is receptive to the specific tubercle bacillus. Among the reasons which confirm me in this view and cause me to differ with the general opinion in this respect I will mention only the one which appears to me of greatest import. Guinea pigs, rabbits and many other animals are infected *spontaneously* by tuberculosis much more infrequently than is man. I have made autopsies on these animals by the thousand and have encountered thereby only isolated examples of spontaneous tuberculosis. Nevertheless in my inoculation experiments I have found that every guinea pig and rabbit is absolutely susceptible to infection by the tubercle bacillus. The size, age, state of nutrition, strength, and health of the animal have absolutely no influence upon the result. When the bacillus was present in the requisite number and virulence, infection was invariably certain to occur, whether the germ was introduced into the subcutaneous tissue, serous cavities, lungs, intestine or blood-vessels. The disease showed invariably progressive development with the eventual production of general miliary tuberculosis leading to the death of the animal. The fact that these animals do not develop tuberculosis under natural conditions cannot, therefore, be ascribed to absence of predisposition, but simply to the fact that under such circumstances the specific bacillus does not enter the body in sufficient numbers and virulence to produce infection. What is true of rabbits and guinea pigs might also be true of man; at least there is no obvious reason why the disease should behave differently in the different species. If but a definite percentage of mankind contracts the disease and dies thereof, the reason should lie in the fact that only a minority of human beings are so situated as to become infected, since bacilli must enter the body in a certain number and virulence to make infection possible. Doubts formerly in vogue regarding this point have been allayed by the recognition of the fact

that the bacillus is not ubiquitous and that it occurs but sparsely outside of animal bodies. The many attempts to demonstrate the presence of the germ in the air of dwellings and the like have not led to positive results. Inasmuch as now the limit of tuberculous infection of man through food products has been drawn still closer, we might wonder why, even with the existing general predisposition, the number of instances of the development of tuberculosis in man and the death rate are not *much* less than they really are, if congenital infection did not also supply an active and frequent mode in addition to infection from external sources.

The assumption of an inborn individual disposition to tuberculosis is, therefore, not necessarily demanded by the facts in our possession concerning the appearance and distribution of the disease in the human race. These facts may also be explained by the circumscribed operation of a tuberculous infection. Prominent authors have recently become inclined toward the view that the so-called individual disposition to tuberculosis is neither more nor less than an indication of "debility" of cell-power. Undoubtedly there is much to sustain this assumption, and I shall return to the subject before closing. But disposition, in a parasitological sense, is manifestly something very different from debility, for the former may occur in the strongest individual of a predisposed species as well as in the most decrepit. This statement is proven not only by similar experiment, but by observation upon mankind, for tuberculosis not infrequently snatches away individuals of athletic power and spares those who are quite delicate. The explanation of disposition is to be sought in all likelihood along biochemical lines, as I have already shown.

In addition to the congenital disposition to this disease, much significance has also been accredited to the acquired disposition. The study of the latter involves us in very complicated problems, because thus far our data do not distinguish sharply enough between the essential disposition of the tissues which allows the parasite to obtain a foothold, and the subsidiary factors by which it is enabled to invade the tissues and diffuse itself within the body. While according to all experiments, undertaken for this purpose, the first named factor, that is the actual tuberculous disposition, can hardly appear to be influenced through other diseased conditions of the body, it is nevertheless conceivable and is supported by observation that the *contributory causes* for the act of invasion and for the dissemination of the disease within the body may be favored or occasioned by pathological conditions of the tissues. To cite only a few examples from the experiences of medical practice, certain inflammatory affections of the air passages and lungs and various

generally weakening or consuming influences such as pregnancy, parturition and diabetes all appear adapted to heighten the inclination to contract consumption.

Affections of the air passages may favor the aerogenous act of invasion through injury of the protective mechanical apparatus which the normal respiratory tract offers against the entrance of air bacteria. This may occur, perhaps, in that the inflammatory secretions afford a suitable culture soil which favors the development of the inhaled bacilli, and also in that they serve as a vehicle of transportation for the bacilli within the bronchial passages. Influences which weaken the body can also facilitate invasion through interference with or entire suspension of the functions of the external protective apparatus; in addition, such influences may facilitate the extension of the infectious process by lowering the general resistance and power of reaction of the tissues. The suspension of, or qualitative anomalies of tissue metabolism, such as we note for instance, in diabetes, may also lead to a greater tendency to necrosis of the parasitical inflammatory process. In diabetes such a tendency is distinguished in a markedly ominous manner not only in tuberculous, but in other inflammations, as, for example those which are produced by pyogenic microörganisms. It must again be emphasized that all conditions like the preceding which favor tuberculous infection have nothing to do with the establishment of a particular disposition to tuberculosis, because the sphere of such favoring influences does not only affect tuberculosis, but also, to a greater or less degree, all infections and all infectious diseases. In the second place it is not on account of these favoring influences that the specific bacillus finds in such a patient the soil for localization and further development. On the contrary, this soil must be presumed to have existed before the advent of the favoring causes. Otherwise, and in the light of all that I have explained and communicated in regard to predisposition and immunity, such diseased or weakened individuals could not have become tuberculous. To the pathologist who makes post-mortem examinations is opportunity given to collect evidence as to the correctness of this view.

Cases of fatal tuberculosis following measles are occasionally reported. In such cases autopsy almost invariably shows the presence of an old tuberculosis of the bronchial glands, which is doubtless of more ancient date than the attack of measles. Closer investigation shows that one or another of the tuberculous glands has ruptured into the larger blood vessels, the hilum of the lung or some portion of the bronchial tree, which is followed either by a general miliary tuberculosis or by a bronchiogenous pulmonary tuberculosis. The measles, then, has not furnished the tuberculous disposition, because the child was

already tuberculous before it contracted the measles. Nor did the measles favor, through its accompanying bronchitis, a new invasion of tubercle bacilli, because the first eruption did not occur through new tubercle bacilli which have entered from without, but through tubercle bacilli which were contained in an old caseous gland. Notwithstanding these arguments the acute disease did, in all probability, exert a most baneful influence upon the course of the tuberculosis: An old localized focus tending to heal or to become latent was caused, through the measles, to ulcerate and perforate the tuberculous glands, thereby converting the tuberculous affection into a progressing and generalizing one.

Quite similar has been my experience in regard to tuberculosis in diabetics. According to my observations from post-mortem examinations of cases of diabetes, instances in which there is no trace of tuberculosis are not so rare as has been commonly accepted. I have also frequently examined cadavers of diabetics in whom the existing tuberculosis undoubtedly antedated the tuberculous affection, and cases in which one could with certainty prove the reversed relation have not come to my notice. I believe, therefore, that to a certain degree I am entitled to the assumption that persons who suffer from diabetes and who develop the clinical evidences of tuberculosis were tuberculous before the advent of the diabetic disease. This position on my part cannot at this time appear so strange when we know how frequently we find more or less circumscribed tuberculous localizations, in the lungs or in other organs, but more particularly in the lymphatic glands, which are tending to healing or to latency, in subjects who during their life have not presented the slightest evidence of tuberculosis. Such, by me, so-called latent tuberculous foci, the origin and benign course of which can evidently be referred to infection with few or with slightly virulent tubercle bacilli, may under certain conditions, which are not fully understood for all cases, become the point of departure for a progressive and deleterious tuberculous affection. Such conditions are, among other diseases, also suppplied by diabetes in which it remains to be determined whether, on account of the abnormal composition of the circulating fluids, the bacilli attain an increase of virulence from a chemical standpoint, or whether under the diminished general resistance and ability of reaction of the tissues the weakened bacilli are capable of more rapid proliferation through which their original degree of virulency is restored.

Thus, in the light of the results of my animal experiments and of my observations at the autopsy table, I arrive at the conclusion that individual disposition is not the controlling factor which governs the

development of human tuberculosis, but that it is the infection with the specific bacillus. Indeed this bacillus attaches itself and thrives only upon a soil which is favorable and chemically adapted to its needs. But we have reason for the belief that this soil exists in all human beings and probably in the same favorable degree. As a result of the action of the bacillus proliferating upon tissues which are predisposed in its favor, and further, as an effect of the reaction of these tissues to the irritating and injurious action of the parasite upon them, we have tuberculosis, a disease proteus-like in the varied multiformity of its lesions. All those products and processes which were formerly held to be heterogeneous—the innocent chalazion, the scrofulous gland, white swelling, lupus, caseous pneumonia, ulcerative phthisis, chronic and acute miliary tuberculosis—have been united under the sceptre of the specific bacillus.

REVIEW OF CURRENT LITERATURE.

INFECTIOUSNESS OF UNCLEAN FINGER NAILS IN CHILDHOOD AS A FACTOR IN THE SPREAD OF TUBERCULOSIS.

Two of the staff of Prof. von Bokay's Pediatric Clinic at Budapest, Drs. Preisich and Schütz have recently made a report upon this subject before a local medical society (*Berl. Klin. Wochenschrift*, May 19, 1902). The children investigated were between six months and two years of age. At this period of life the act of creeping brings the nails in constant contact with the dust and dirt which accumulate upon the floor. At this age, too, the children are addicted to sucking their fingers and picking their noses. The dirt was removed from beneath the nails with a sterile sound, and while a portion was studied microscopically the rest was used for animal inoculations. The latter proved highly unsatisfactory, as a number of the guinea pigs perished promptly from some acute infectious disease which was not tuberculosis. Realizing the impossibilty of demonstrating the existence of the latter disease in the presence of this acute infection the authors depended thenceforth exclusively upon the microscopic test. Here, indeed, the increasing difficulty of distinguishing between the true bacillus tuberculosis and numerous similarly staining bacilli must be reckoned with, but the authors used as control the genuine bacillus as found in tuberculous sputum.

The general outcome of these studies appears to show that of the 36 children investigated, 14 contained the tubercle bacillus under their nails; but as some of the germs thus encountered did not respond to all the identification-tests of the sputum-bacillus, the actual number of positive results is placed at five.

Assuming that in the 14 cases the examples of tubercle bacilli may all have been genuine, a search for a possible source of the germs showed that in six or perhaps seven cases some member of the household from which the child proceeded was tuberculous. In the 52 negative cases there were but five examples of tuberculosis in the household. It is a matter of great interest that bone tuberculosis predominated somewhat over the pulmonary type in the possible sources of infection.

Hitherto too little attention has been paid to the pus of tuberculous ulcers and sinuses as a transmitter of the disease, although the existence of this factor has been recognized by authorities like Potain, Lancereaux and others. The subject is entirely ignored by Heubner, Marfar and D'Espine, and has also failed of mention in several of the Congresses for Tuberculosis.

Open bone and gland tuberculosis is of course extremely common in childhood, and but a small portion of the cases are to be found under hospital treatment. Cared for as they are at home, these children must be able to contaminate their surroundings through the discarded dressings, bathing-cloths, etc. The tendency of the dried pus is to find its way to the floor.

In the animal experiments already mentioned, those which did not end fatally from a collateral acute infection of some sort resulted negatively. It is probable that but few bacilli are actually present under the nails.

The high mortality from tuberculosis at the period of life which corresponds to the ages of the children investigated is in all probability due to the infectiousness of the dirt of the floor. The exposure, trifling in some respects is nevertheless relatively continuous and therefore cumulative.

Sooner or later some slight defect within the nose or mouth becomes infected and the bacilli are transported to some of the neighboring glands.

VARIETIES OF TUBERCULOSIS AND METHODS OF ITS DIFFUSION.

Benda (*Trans. Brit. Congress of Tuberculosis*, III., 523.) read the opening paper on this subject at the London meeting of 1901. A consideration of the diffusion of the bacillus gives us an idea of the varieties of the lesions. The bacillus itself is immobile, grows slowly and provokes a severe reaction whenever it takes firm hold. These three properties enable us to understand why the organism is able to repel the invasion of the germ under certain conditions. Whenever tubercle can spread by continuity alone, the process is always a slow one.

But although passive, the bacillus may be transported in different ways. Koch, himself, showed that the migratory cells distribute these germs throughout the body. Generally speaking any method by which transportation may be effected within the body may be utilized by the bacillus.

The epithelial passages of large organs like the lungs and kidneys may play a prominent part in the transportation of this germ. No matter how these organs become infected, be the infection primary, secondary, or metastatic, the epithelial tissue always participates. Thus, whether infection of the kidney is direct, haematogenous or metastatic the epithelia of the urinary tubules are always involved and contain the bacilli often in large number. When the germs reach the excretory

ducts of glandular organs, it is possible for them to be transported farther in various ways. On the other hand in the finer terminal passages diffusion occurs in this direction. We find therefore that the disease becomes arrested in the cortex of the kidney, and that *phthisis renum* is essentially an affection of the medullary substance.

In tuberculosis of the liver the biliary passages are first attacked and this principle holds good for organs of the same character.

If the ducts of an organ are flooded with bacilli, the latter will be carried both upwards and downwards. We can readily see that in the case of the lungs, the respiratory current tends to carry the germs in both directions. It is difficult to understand why the trachea and larynx are not more frequently attacked by the disease, and it is still harder to comprehend why the entire lung is not infected from the lesions in one bronchus. For when the expiratory current carries matter from the latter into the main bronchus, the inspiratory air should transport the germs into other portions of the bronchial tree. Yet we know that the disease may remain localized for a long period. When a caseous bronchial gland ruptures into a main bronchus, thereby conveying tuberculous virus into the bronchial tree, the only portion of the lung infected as a rule is that which corresponds to the seat of the rupture.

The methods of diffusion of the bacillus throughout the urinary system have been much discussed. We know that infection may travel from the kidney to its pelvis and thence to the ureter and bladder, and we have taken it for granted that the process may extend from the bladder along the opposite ureter and thus reach the other kidney. Finally it has been assumed that the epididymis and testicle could be infected from the bladder and prostate, that one epididymis may infect its fellow through the vasa deferentia, and that primary disease in the genital adnexa could extend upwards into the urinary organs. Baumgarten has attempted to discredit some of these possibilities, claiming that in the urinary organs there is no centripetal movement of the secretions; but he overlooks the principle of antiperistalsis—a condition which while not yet noted in the vas deferens is commonly encountered in the muscular tubular structures.

The subject of epithelial metastasis could be carried still further—as in the case of infection transported from the lungs into the intestinal tract.

The importance of the rôle of the lymphatic system in the diffusion of tuberculosis is well understood. The old theories in regard to the manner in which lymphatic metastasis is effected have given way

to Koch's view that the bacilli are simply carried onward by the leucocytes. Anything like an universal infection of the body throughout the lymphatic system could only occur in case of participation of the thoracic duct; for it is readily apparent under the microscope that tuberculosis of the lymph vessels results in the obliteration of the latter. Infection of a lymph-node results in infection of the distal lymphatics with closure of the latter; while if the lymph-node itself escapes infection the onward march of the bacillus is likewise arrested.

The subject of transportation of the bacillus by the blood-vessels is one of great interest. We may safely assume that the smaller vessels always participate in tuberculosis of any organ. As in the case of the lymphatics, these structures become obliterated by the disease.

When, however, larger blood-vessels become involved the results are different and the bacilli are then able to enter the circulation. This form of tuberculosis has been studied in the heart, larger blood vessels and thoracic duct. It does not follow that infection of these structures results necessarily in the entrance of a large number of bacilli into the blood, because clots may form in situ and cover the tuberculous lesion and through subsequent organization render it harmless. Even in the absence of this phenomenon, the blood may escape infection. because of the poverty of the lesion in bacilli. In the cases of tuberculosis of the vessels in which not very many tubercles are present and in which not many tubercle bacilli gain entrance into the blood, the diffusion of toxins in the blood explains the fever which constitutes an important part of the clinical picture of acute miliary tuberculosis. We do not know as yet that the bacilli can multiply in the blood, although certain clinical phenomena (progressive miliary infection) appear to sanction this hypothesis.

ON THE RELATIONSHIP BETWEEN CERTAIN CASES OF RECOVERY FROM PHTHISIS AND THE FORMATION OF JOINTS IN THE CARTILAGE OF THE FIRST RIB.

Freund, who has advanced a theory that the disposition of the apex of the lung to phthisis depends upon defective development of the first costal cartilage, contributes a paper upon the same subject in the *Berl. Klin. Wochenschrift*, 1902, No. 33.

At a meeting of the Hufeland Society of Berlin, von Hansemann had made a distinction in reference to recovery from phthisis. He had spoken of "healed phthisis of non-bacillary origin," by which term he distinguished cases of cicatrized bronchiectatic cavities, syphilomata,

fibrinous pneumonia and actinomycosis from phthisis proper. The differences between the two types of healing were sharply marked. The essential distinction did not lie in the character of the tubercles, but in the presence or absence of the bacillus. Tuberculous phthisis originated in the mucosa of a bronchial tube or as cheesy hepatization which could develop from a gelatinous pneumonia. Both types of the lesion were of bacillary origin and both could undergo recovery if miliary tuberculosis did not supervene, the latter being incurable. Tuberculous phthisis almost always begins at the apex. Recovery may occur by resolution, in which case hardly a trace of the disease would be left, or by cicatrization. In the latter case a mere cicatrix might result, with no inclusion of tuberculous tissue; or the scar would possess a calcified caseous centre within which bacilli might long survive in a virulent state; or, finally, the cicatrix might enclose a cavity which, as a rule, communicated with a bronchial tube. Such cavities may develop an epithelial lining, and even tubercle bacilli may be found within, but without causing further infection.

Freund now returns to the subject of the first costal cartilage and recapitulates his doctrine—the result of 45 years' study—as follows: Some individuals have the first costal cartilage in a state of arrested development. It is unnaturally short, broad and firm, and thereby interferes greatly with the normal twisting of the first rib during inspiration. The inspiratory muscles undergo compensatory hypertrophy and their attachments to the rib and cartilage become the seat of perichondritis and periostitis, leading to ossification; so that the anterior surface and two borders of the cartilage become sheathed with bone. In certain cases a fracture takes place in the ossified cartilage with formation of a false joint.

Freund has been able to demonstrate all of these changes from anatomical specimens which have been shown before societies and illustrated. These include, in addition to what has already been indicated, preparations with free joints, the manubrium and sternum proper, which formation may also compensate when present for immobility of the first rib.

Freund next compares his findings with those of von Hansemann. It is evident that the latter's "non-bacillary phthisis" can have no necessary connection with the anomaly described by Freund. The latter constitutes a predisposing cause of bacillary phthisis and cannot in any way favor the development of the non-bacillary lesions described by von Hansemann, which, however, do not have a seat of predilection in the apex. The formation of false joints in the superior aperture of the

thorax would of course exert no favorable influence over the diseases which have been styled non-bacillary phthisis.

On the other hand, in tuberculous or apical phthisis the formation of joints in the first rib or between the manubrim and corpus sterni would permit increased ventilation of the apices, improved circulation of blood, augmented expectoration, etc., and would thereby directly favor recovery with production of the form of healing described by von Hansemann.

In Freund's earlier papers, the coincidence of recovery from apical tuberculosis with these compensatory changes in the muscles and bony structures of the upper thoracic aperture is mentioned as having been verified repeatedly upon autopsy. The author reiterates his suggestion of dividing or resecting the first rib in threatened phthisis.

ON THE INTERPRETATION OF THE LESIONS CAUSED BY THE BACILLUS TUBERCULOSIS.

Hamilton (*Trans. Brit. Congress of Tuberculosis*, III, 530.), states that certain questions in the pathogeny of phthisis remain unanswered. For example, why are certain tissues immune to the attacks of the bacillus? Why do some lesions remain local while others infect? We do not know why the bacillus sometimes refuses to stain.

In regard to natural inoculation the lung and ileum are the portals of choice; the author has never seen but one case of primary tuberculosis of the stomach. The duodenum, upper two-thirds of the jejunum, pharynx and oesophagus are very seldom attacked primarily by the bacillus. Why should the lower portion of the small intestines be so much more vulnerable than the upper part of the alimentary canal? We can answer only by pointing to the analogy which is apparent here between tuberculosis on the one hand, and typhoid fever, sepsis, etc., on the other. When typhoid germs are ingested, when virulent pus is swallowed, we see infection begin at the ileum, although the upper portion of the gut, provided with the same absorbents and similarly exposed to infection, enjoys some sort of immunity.

The author has seen many cases of tuberculous cervical glands in which he could find no port of entry for the bacillus save carious teeth. There is no evidence that the teeth, gums, or jaws are attacked by the germ in its passage to the lymph-nodes; and this fact furnishes an argument in support of the view that the bacillus may penetrate the skin, mucosae, etc. without causing local lesions. It is impossible otherwise to explain the appearance of isolated tubercle in the bones, joints, peritoneum, etc. Furthermore, we know that the germs of anthrax, the

plague, etc., do not cause lesions at the point of entry.

In regard to the mode of diffusion of the bacilli in the body, evidence appears to show that this occurs by the lymphatics rather than by the blood-stream. There appears to be no definite relationship between the number of bacilli absorbed and the character of the lesions; nor is there any regularity of involvement on the part of the tissues. This is what one would expect of a lymphatic infection. But when the germs really gain the blood-stream in large quantity, a more or less generalized infection necessarily results. The predominance of the lymphatics in diffusing the disease is very obvious. Thus from a focus of tuberculous caseous pneumonia, nothing is more common than to see the radiating lymph-vessels attacked by secondary tubercle. Recently it has been claimed with some degree of probability that infection may be transmitted along the lymphatics in the reverse direction, i. e., against the natural current.

It is a singular fact that in primary tuberculosis of the intestine and peritoneum, the lymphatics of Glissons's capsule may be studded with tubercles, while the liver substance remains healthy. This discrepancy is best explained by the supposition that the bacilli thrive in the lymphatics but perish in the blood. We know that the hepatic capillaries have a tendency to arrest foreign particles of all kinds, and it appears probable that the leucocytes, having a higher phagocytic quality than the lymphocytes, dispose of the bacilli as soon as they reach the portal blood.

In regard to giant cells, they are never encountered in primary tuberculous pneumonia and hence are not an essential phenomenon of tuberculosis. They may be seen in secondary lymphatic tubercles. The giant cell is evidently derived from connective-tissue alone, being in fact an overgrown connective-tissue cell. For this reason we do not encounter it in tuberculous catarrh. In some of the lower animals we find the giant cells packed with tubercle bacilli, while in other species not a solitary bacterium is discoverable in these formations. In other words their phagocytic properties vary with the animal. The barrier of young living cells about chronic tubercles doubtless prevents the diffusion of bacilli to a certain extent, but this defensive apparatus may give way under various circumstances, especially when the bacilli thrive to such an extent that a pure culture results with accompanying liquefaction of the tubercle.

The outward aspect of tuberculous formations varies more than in any other form of tumor-disease. There may be produced large masses which resemble cancer and sarcoma. The tendency to caseation varies greatly with the species of animal, and when it is absent or nearly so,

huge sarcoma-like masses are readily produced. In organs having excretory ducts tuberculosis assumes one of two types, viz.: miliary or catarrhal, the former being of haematogenous origin.

The nature of caseation is still a mystery. Probably a necrosis inducing substance is formed in the bacillus after its death. A singular unexplained peculiarity of ulcerating tuberculous tissues is the absence of any odor of putrefaction.

ON THE DIAGNOSIS OF THE INHERITED PREDISPOSITION TO PHTHISIS.

Sticker, (*Münch. Med. Wochenschrift,* August 19, 1902) states that recovery occurs more frequently than death when an individual has been attacked by tuberculosis. This fact may be explained in three ways, viz.:—

1. The virus may be of different intensity.
2. Complicating factors may coëxist.
3. There are differences in receptivity to the infection which may include both local and general elements.

Differences in virulence are in evidence clinically, for an insidious invasion of a community may pass by degrees into a veritable scourge; while conversely, a stock of tuberculous antecedents may become slowly immunized, the disease dying out. Such intensifying and weakening of virulence may also be observed in the laboratory. There is no doubt that our conception of the bacillus is too loose in character and that more attention should be paid to race, species and variety.

In regard to the coöperation of extraneous factors in the production of what is clinically tuberculosis, such conditions may of course act by raising the virulence of the germs. Under this head belong alcoholism, other diseases, defective nutrition, etc.

It is evident, however, that this subject of relative virulence is not broad enough to account for the fact that individuals and families often exhibit a special susceptibility to infection. This predisposition may be a purely local affair, or may involve the entire constitution of the individual.

The morphology of the special victim of tuberculosis has been studied in detail and the peculiar thorax, small heart, etc., have been carefully described. But this line of research has left us in the lurch; and the future should take more cognizance of the physiology of these candidates for consumption. Functional aberrations are more readily recognized and measured than anatomical deviations. We should determine such points as the organic capacity of the lungs, the power of regeneration of epithelium and connective tissue, the metabolism, leu-

cocytosis, antitoxic capacity and the like.

In his investigations upon pneumatometry the author found his path beset with difficulties. It appeared to be impossible to determine the organic capacity of the lungs in a satisfactory manner. He succeeded to some extent, however, in measuring the force of the inspiratory muscles by an apparatus which he terms the thoraco-dynamometer.

He determined that the inspiratory force of healthy men from 19 to 25 years should be from 32 to 46 kilos for a single maximum effort, and from 30 to 44 kilos for the constant exertion, kept up from 10 to 20 inspiratory efforts. His subjects were infantry soldiers, and the power of the right hand was also taken by the dynamometer. Of two individuals with good hand power, but strikingly small inspiratory force, one exhibited commencing phthisis, while the other had enlarged tonsils and pharyngeal and bronchial catarrh. Following up this clue he found that the disproportion between the strength of the grip and inspiratory power was often accompanied by such conditions as bilateral apex-catarrh, pleuritic and bronchial affections, etc. After fever and dyspnoea had developed, the consumptive sustained a rapid loss of inspiratory force.

Attention was next turned to individuals who presented the traditional picture of congenital disposition to phthisis. He measured 23 young people whose ages ran from 17 to 24 years. They exhibited such stigmata as paralytic thorax, and delicacy and slenderness of build, and some of them had grown rapidly after puberty. All were apparently free from tubercle and were healthy enough save for anaemia, palpitation and lack of endurance. The dynamometer in this series ranges from 18 to 39 kilos. While the maximum inspiratory effort was 22 to 23 kilos and the steady effort from 18 to 26 kilos. All these individuals showed retarded development of the heart, as indicated by the anomalous site of the apex-beat.

Further investigation along this line has convinced the author that the diminished inspiratory power of the types of individuals studied adds another diagnostic token of incipient phthisis, the pretuberculous state, the candidate for tuberculosis, etc.

ON THE DIAGNOSIS OF THE PULMONARY ALTERATIONS PRODUCED BY THE INHALATION OF DUST IN CONNECTION WITH VARIOUS OCCUPATIONS.

Bäumler (*Münch. Med. Wochenschrift,* 1900, No. 16) states that all physicians who practice much among artisans, whether in hospitals or in the private pursuit of their callings, must be more or less familiar with a condition which simulates chronic pulmonary phthisis with the

striking exception that it pursues a favorable course. A study of the antecedents of these patients leads to the conclusion that tuberculosis plays little or no part in the production of these benign affections.

The individuals who are subject to these pulmonary troubles are usually in middle life or of more advanced years. While chiefly of the male sex, some of them are women. The initial picture is one of cough, expectoration, consolidation in the upper portion of the lungs, and more or less extensive bronchial catarrh. Fever is slight or absent, at least as an initial phenomenon. The symptoms just enumerated, taken in conjunction with the profuse muco-purulent expectoration, the poor nutrition and defective circulation, appear to point toward the existence of tuberculosis, although Koch's bacillus is not found in the sputum.

If these patients are placed under favorable hygienic conditions, they may be seen to recover with surprising rapidity; so that nothing remains to tell of the past save certain phenomena of consolidation and slight bronchial catarrh. These subjects are able to earn their living and may remain well indefinitely, although sooner or later it is not uncommon to note the supervention of emphysema or cardiac disease. Autopsy usually shows the presence of induration at the apices, emphysema, pleural adhesions, and a dilated hypertrophic heart. It will be learned that all such patients have worked for a term of years at some occupation which necessitates a constant inhalation of dust.

These intra-thoracic alterations which are known collectively by the term *pneumokoniosis* are found in connection with a number of callings.

Before 1870 it was known that stone-cutters, millers, grinders, bakers, miners, flax-spinners, tobacco-workers, etc., were subject to this type of disease. Some of the original authorities on pneumokoniosis were Virchow, Zeuber, Merkel and Arnold. The pathogeny of this process is as follows:—Particles of dust enter the lymph-channels of the bronchi and lung-tissue and are transported to the bronchial and mediastinal lymph-nodes and also to the intra-alveolar and sub-pleural connective tissue. Here they locate and give rise to the production of new connective tissue with subsequent sclerotic changes. The pleura may become studded with fibrous nodules which are surrrounded by areas of pigment. Lymph-nodes are seen to have undergone contraction about pigmentary deposit. These fibroid changes have been known to extend to contiguous structures like the oesophagus and recurrent laryngeal nerve, with the production of serious structural and functional changes.

The consequences which next follow dust inhalation are bronchial catarrh—at first in serial attacks which become more and more fre-

quent and prolonged. Emphysema develops at the same period, and from time to time attacks of broncho-pneumonia supervene with marked participation of the interstitial tissue, leading in turn to induration and sclerotic change. Pleurisy is a natural sequence to the changes just narrated, and may be attended with exudation, but is, as a rule, dry and succeeded by thickening and adhesions. The changes in the lung already narrated lead in time to formation of atelectasis and bronchiectasis in the lower lobes. Tuberculosis may of course be superadded to the preceding picture, and cause the patient to succumb rapidly; when bronchiectatic cavities have formed, putrid bronchitis may develop, especially when the dust inhaled is of foul character, but in a certain class of cases, the coincidence of pneumokoniosis and tuberculosis, so far from being prejudicial to the patient, appears to result in recovery from the latter disease. It is not improbable that cases of tuberculosis have often been partly arrested by the hyperplastic changes which result from the persistent inhalation of dust. We must therefore be careful in practice to differentiate between pneumokoniosis which is not complicated with tuberculosis, and the slowly advancing type of the latter in which the constant inhalation of dust has exerted a modifying influence by producing indurative and sclerotic changes.

The contraction undergone by the connective tissue produces a shortening of one or both apices which may be recognized by percussion. The anterior margins of the upper lobes of both lungs may be similarly involved. Since I became aware of this fact, I have encountered these changes a number of times, either with or without the corresponding changes in the apices. Most of the cases were examples of simple pneumokoniosis, having neither fever, nor bacilli in the sputum. In certain instances the remainder of the lungs was emphysematous. The following case will be very instructive: A man aged 59 was admitted to the clinic with a severe diffuse bronchitis. He showed a pronounced emphysematous habit and complained of dyspnoea, chiefly expiratory in character. There was much cough with muco-purulent sputum containing neither tubercle bacilli nor influenza bacilli. There was no fever, the pulse ranged from 72 to 96 and the respiration was rapid (48-56). Sonorous and sibilant râles were audible everywhere over both lungs. The impulse of the apex of the heart could not be made out. There was cardiac hypertrophy and the liver was both enlarged and depressed. Some ascites was present and the urine contained albumin. Upon percussion of the thorax the usual evidences of emphysema were not too apparent. The percussion note at the back of the lungs was indeed overfull, but in front, the lung tissue was in part displaced by the enlarged heart and in part retracted as a result

of old inflammatory changes; so that in no place did it overlap the anterior mediastinum. The patient was a confectioner and before giving up his occupation had been exposed to a very dusty atmosphere. He had had two severe attacks of pulmonary haemorrhage, which had necessitated a sojourn of 10 weeks in the hospital. It is very evident that the man originally had tuberculosis, which produced apical changes, while at a later period he went through an experience with pneumokoniosis which led to the alterations in the remainder of the lung tissue. The last named affection in turn caused the changes in the heart and vascular system.

The peculiar changes in the anterior borders of the lungs enable us to diagnosticate the presence of pneumokoniosis by percussion and are therefore of great practical significance, especially in respect to the coincidence of tuberculosis. Whenever we find this retraction in a patient who has been tuberculous as well, we may infer that the progress of the infectious disease has been arrested. If a patient with tuberculosis develops pneumokoniosis, the prognosis for life is improved.

ON THE PROGNOSIS OF TUBERCULOUS MENINGITIS.

Gross (*Berl. Klin. Wochenschrift*, August 18, 1902) begins his paper by an allusion to the definite relationship which may exist between the cause of a disease and the prognosis. Hence the importance of a bacillary examination whenever specimens are obtainable. Lumbar-puncture has greatly added to our prognostic resources through enabling us to make differential diagnosis. We now know that tuberculous meningitis is not incurable, because of the coincidence of bacillary findings with recovery. The author has an instructive case to report in this connection.

A youth of 17 was taken suddenly ill with violent headache. He took to his bed soon afterwards and vomited upon an empty stomach. The bowels became obstinately constipated. Systematic examination showed rigidity of the spine, fever (39° to 40° C.), slow and dicrotic pulse and boat-shaped, retracted abdomen. The skin showed the customary vaso-motor irritability. Photophobia was present and the excruciating headaches persisted. The patient was otherwise intact, and there were no disturbances of the cranial nerves. The disease might possibly have been of traumatic origin, for five days before its supervention the boy had been hit over the parietal bone with a beer glass. The skin at the site of injury had sloughed but the bone beneath was found intact. It was difficult to understand how this lesion could have induced intracranial infection, so that the diagnosis was thought

to lie between the simple serous meningitis, epidemic cerebro-spinal meningitis, and tuberculous meningitis. The sudden onset and absence of old tuberculous lesions spoke against the latter, but a history with cicatrices of suppurating glands in childhood somewhat offset this point. On the other hand the absence of herpes febrilis and the course of the fever which had abated, spoke against the likelihood of epidemic meningitis. The injury might perhaps have caused a serous effusion or even haemorrhage, with production of simple meningitis. Owing to the impossibility of making an exact diagnosis, lumbar puncture was performed. The fluid was found to be cloudy, a coagulum separating after standing. The sediment consisted chiefly of polynuclear leucocytes, but contained microörganisms at first sight. After repeated search, however, 3 acid-proof bacilli were recognized among the leucocytes. Further research, attempts at cultures and animal-inoculation all resulted negatively. The meager find of bacilli was held to establish the diagnosis of tuberculous meningitis, because in well marked cases of the latter all tests of the cerebrospinal fluid have been known to fail. The trauma now came into consideration as an exciting element in the development of the disease, which often appears after some such history.

After an illness of 16 days the boy made a complete recovery from the meningitis but a careful exploration of the lungs revealed certain evidences of bilateral apical involvement, so that whatever doubt might have remained as to the nature of the intracranial affection was now removed.

TWO CASES IN WHICH THE ACTIVITY OF PHTHISIS WAS EXCITED BY OPERATIONS FOR LOCAL TUBERCULOSIS.

Rodocanachi (*London Lancet*, Jan. 18, 1902) gives a brief narration of two cases as follows:

1. Man, aged 40, with disease affecting a metatarso-phalangeal joint. History of some strumous disease of the lower jaw which had healed. There had been some cough before the operation, but no evidence of pulmonary lesions. Before surgical intervention was practiced the patient was put upon a roborant plan of treatment. During the month of May the diseased bone was gouged away, and during the period of healing the toe corresponding to the metatarsal bone became gangrenous and came away. The immediate result was excellent, but the cough became worse and the patient was dead of rapid phthisis in less than two months after the operation.

II. Man, aged 22, with enlarged inguinal glands on both sides. This patient also had a cough, but his sputum contained no bacilli. There were physical signs over one apex which pointed to tubercle. An attempt was made to build up the patient's general nutrition and to cause resolution of the glands. It became evident, however, that pus was forming and the glands were extirpated; in the course of the operation several large veins were wounded. Three days later the temperature rose several degrees and never subsided. A diagnosis of sepsis was followed by the exhibition of Marmorek's serum. Improvement appeared to result and the wound began to granulate naturally. The thoracic symptoms, however, became worse, bacilli appeared in the sputum, vomiting set in and death occurred from exhaustion about three weeks after the operation.

TUBERCULOSIS OF THE APPENDIX AND RIGHT UTERINE APPENDAGES.

Kraus (*Monatsschrift für Geburtshülfe und Gynaekol.*, February, 1902) states that there was no suspicion of tuberculosis in his case, as the patient was strong and florid in appearance. The diagnosis was tumor of the right uterine appendage of unknown origin. There was a history of two attacks of peritonitis, with ten years interval. The tumor was extirpated and was found to consist of the right tube, a piece of altered omentum, the appendix and a spheroidal mass which was found to consist of tuberculous granulation-tissue. The uterine appendage and the appendix vermiformis were also found to be tuberculous.

The author attempts to explain the rationale of this case as follows:—The first attack of peritonitis, having been violent in character, was in all likelihood non-tuberculous and of appendicular origin. It may reasonably be assumed that the appendix was left in a vulnerable condition and was eventually infected with tubercle bacilli from the intestine. The second attack of peritonitis ten years after the first was doubtless tuberculous. It pursued a highly chronic course, and even the formation of an abscess (perhaps from perforation) was unaccompanied by any violent symptoms. The formation of pus extended toward the ovary beneath the peritoneal investment of the latter. The so-called appendiculo-ovarian ligament directly favors this extension of disease.

The ovary was completely disintegrated by the suppurative process, but despite this fact it did not become tuberculous. The tube, however, was readily infected through its abdominal ostium and became obliterated. The author believes that this case is unique.

ORIGINAL ARTICLE.*

THE PRODUCTION OF IMMUNITY AGAINST TUBERCULOSIS IN CATTLE THROUGH "JENNERIZATION."†

BY GEHEIMRATH PROF. E. VON BEHRING OF MARBURG, GERMANY.

In speaking of "Jennerization," I mean thereby the protection of an individual against infection through intentional inoculation of a modification of the same virus which produces the disease against which protection is sought—of a modification which by proper application is harmless to the individual whom we seek to protect.

While to the present time I have found no absolutely harmless tuberculosis-virus for healthy young cattle, I have nevertheless demonstrated in my institute a relatively harmless virus in the form of pure cultures of tubercle bacilli derived from human sources, further in cultures originally obtained from a tuberculous fowl, in the Arloing tubercle bacilli, and finally in cultures of bovine tubercle bacilli which were reduced in virulency by treatment with trichloride of iodine.

The virulency of human tubercle bacilli cultures obtains a greater degree when they are first passed through goats or sheep, and are then used for inoculation of cattle; they are, however, reduced in virulency after having been grown on artificial media for a long time. In my method of Jennerization I have preferably employed the latter kind.

In order to secure a perfectly uniform dosage for protective inoculations, and especially when the material to be used is to be sent to distant points, I use the pure tubercle cultures in a dry state, and in connection with an operative course which I gave last August, I formulated the method and dosage as follows: "The protective virus for the first inoculation consists of living human tubercle bacilli the effect of which upon cattle has been carefully examined in the Institute for Experimental Therapy at Marburg."

For the first inoculation the tubercle bacilli are employed in a dried state without, however, having lost their vitality. When kept in sealed glass tubes during a period of 30 days, these dried tubercle bacilli remain unimpaired in their action upon cattle, and can be used for their immunization without hesitancy within that time, from the date which appears upon the label of the vial.

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*The printing of *The Journal of Tuberculosis* was too far advanced on the arrival of this article to insert it under "Original Communications."

†Written for *The Journal of Tuberculosis*, and translated from the author's manuscript.

While the immunization value is not entirely lost even after this period has elapsed, it is diminished to a degree which renders the material useless.

Each glass tube contains an exactly weighed quantity of tubercle bacilli and each animal receives as a first dose four milligrams. The vial contains 25 doses (100 milligrams).

For injection the tubercle bacilli are prepared by the following method:—

First the whole contents of the tube are pulverized in a mortar in the dry state and then rubbed into a homogeneous emulsion by gradual addition of two or three cubic centimeters of a boiled and subsequently cooled one per cent. salt solution.

This emulsion is then poured into a graduated cylinder of 50 c. c. capacity, care being taken that every particle of it is washed out of the mortar by rinsing repeatedly with the salt solution until the cylinder contains exactly 40 c. c.

The contents of the cylinder are now transferred to a sterile, wide-mouthed flask, holding 100 c. c. and 10 more cubic centimeters of the salt solution are used for rinsing the cylinder and are added to the 40 c. c. in the flask, which now contains 50 c. c. of the virus ready for injection, of which 2 c. c. represent the proper dose for the first inoculation, provided that the tube contained 25 doses or 100 miligrams. This method has been followed by those who attended my course and no undesirable effects were observed either in my institute at Marburg, or on a farm in the neighborhood.

That the dried tubercle bacilli so used are however not absolutely without danger to cattle, is shown by a large number of laboratory experiments in which under the use of larger doses of emulsions in which the tubercle bacilli were not uniformly distributed, the animals became ill with high fever and manifested clinically demonstrable local lung changes which disappeared in the course of 8 to 14 days.

The dose of dried tubercle bacilli which I regard as an immunizing unit, has for cattle approximately the same degree of virulent power as have 2 milligrams of a six weeks old serum culture; a conclusion which I arrived at by comparative experiments. Now if one immunization unit, that is four milligrams of dried tubercle bacilli, is equal in virulency to 2 milligrams of serum culture, the former contains 10 times as many tubercle bacilli as the latter, showing that my dried tubercle bacilli represent a modification of reduced virulency.

The toxic value of four milligrams of dried tubercle bacilli is equal to about 0.05 gr. of Koch's tuberculin; but it should be noted that the same amount of tuberculosis-toxin is greater in its effect upon

tuberculous cattle when given intravenously than when applied subcutaneously.

Cattle which are highly sensitive to tuberculin show, after intravenous injection of four milligrams of dried tubercle bacilli, a fever reaction which is identical with a positive tuberculin reaction; and from the temperature curve of such cattle we can as readily determine the presence or absence of tuberculosis, as we can from that following a diagnostic injection of tuberculin.

In a large number of instances cattle, which had a short time before given a positive tuberculin reaction and which could therefore be regarded as tuberculous, were treated by inoculation of dried tubercle bacilli. The fever reaction following upon the inoculation with dried tubercle bacilli was then always more intense than it was in cattle which had not reacted to tuberculin, and a cough lasting several days appeared almost invariably as a consequence. Finally after an average of 10 days the fever and cough disappeared. It is my present belief that young cattle up to six months of age can receive a successful protective inoculation although already tuberculous, provided they do not show any other symptoms of tuberculosis except a high degree of susceptibility for tuberculin. But cattle which must be considered tuberculous from the results of external inspection and of physical examination I exclude from protective inoculation under all circumstances.

In view of the fact that young cattle do not suffer any disadvantage from protective inoculation, even if tuberculous to a degree that they give a tuberculin reaction, and of the fact that the protective inoculation with dried tubercle bacilli can itself be utilized for diagnosis, I believe that a preliminary tuberculin test is no longer necessary.

The protective inoculations with dry tubercle bacilli and with fresh serum culture have at present (September, 1902) been performed in such numbers that we need entertain no serious apprehensions of doing harm. In more than 100 cattle from the age of three to twelve months thus inoculated, no harmful consequences were observed. In a village near Marburg (Wehrda), two such animals were slaughtered several months after the protective inoculation; they were found in an excellent condition of nutrition and without any trace of tuberculous disease.

But while I emphasize the harmlessness of the protective inoculation, as described above, I must also declare that at present I am unable to guarantee that these protective inoculations will accomplish their object in that the treated animals will be protected against infection to which they are liable under natural conditions.

As I have already stated in my book on tuberculosis,[1] an observation of several years of such practice is necessary in order to arrive at a final conclusion. In the meantime I consider these protective inoculations as a preliminary attempt to prove my laboratory experiments, and I have therefore made this attempt at my own cost and upon my own responsibility, so that owners of cattle, who will permit the inoculation, will be put to no expense.

My laboratory experiments prove that protective inoculations produce an increased power of resistance against subsequent intentional infections,but not as yet to a degree that the usual fatal dose of the bovine virus is well tolerated. While I presume that such a method of immunization (which would take much more time and prove more costly than a single protective inoculation) will be found unnecessary for the practical purpose of protecting cattle against ordinary infection, I am not in a position to assert this positively, and to settle this question an increased amount of experience in agricultural practice is required.

For this purpose the animals already inoculated will probaly be sufficient, and for my part I do not intend to further continue with additional inoculations until I actually know that those heretofore made are not only harmless, but that they have also accomplished their object.

In the meanwhile I am considering the possibility that one single protective inoculation may not suffice, and accordingly a second inoculation has been made in a series of animals located upon different estates. Still other animals have been preliminarily treated with other tubercle bacilli modifications which are but slightly virulent for cattle. Further particulars may be found in my publication heretofore cited. My present object is to describe more fully the protective inoculation which is made but once, and which will probably become the foundation for all future modes of immunization.

LABORATORY EXPERIMENTS CONCERNING THE IMMUNIZATION OF CATTLE AGAINST TUBERCULOSIS.

Inasmuch as I am at present not able to claim entire success for my protective inoculation, the confident manner in which I am testing the method for the purpose of subduing bovine tuberculosis may be somewhat striking. But it will appear less so, after studying thoroughly the contents of my book on tuberculosis which I published together with Ruppel and Römer, and if especial attention is given to the following facts calculated to supplement what has there been stated.

My confidence is based on the results obtained from a long series

[1]Heft 5 of Behring's Beiträge zur Experimentellen Therapie: Marburg, Lahn, 1902, Elvert' sche Buchhandlung.

of laboratory experiments, which proved on the one hand the harmlessness of the method of inoculating with a virus of human origin, and on the other hand the immunity of the inoculated cattle against infection with a bovine virus that produced a fatally ending tuberculosis in animals used as controls.

These two assertions I wish now to prove by particular reference to facts cited in my book.

1. THE HARMLESSNESS OF MY METHOD.

In 1895, 1896 and 1897, I infected more than 20 grown cattle either subcutaneous, intravenous or intraperitoneal with bouillon cultures of human tubercle bacilli, and in no case was such an inoculation followed by a single symptom of general tuberculosis; when these animals were killed at shorter or longer periods after infection, the chest and abdominal organs proved to be entirely free from tuberculosis. In the years following, I have also made inoculations in young cattle, for the purpose of determining the question of dosage, and in these experiments I substituted tubercle bacilli grown on solid media for bouillon cultures. The result was that healthy, young cattle, five to 12 months old, became ill with fever after an intravenous injection of an emulsion containing not more than 0.02 gr. of tubercle bacilli grown on the surface of obliquely stiffened serum. In some cases cough also followed, lasting from three or four to 20 days, but without any exception recovery was complete. If the intravenous injection contained more than 0.02 gr. of tubercle bacilli the young cattle became seriously ill, and in some cases a genuine pneumonia was demonstrable upon clinical examination. During 1901 and 1902, I used in my Marburg institute 30 young cattle for the purpose of observing the effect of immunizing doses on their general health, and I am able to assert that intravenous injections of not more than five milligrams of dried tubercle bacilli in the form of a well prepared emulsion can be given without hesitation for a first inoculation. In many other individual cases and upon various large estates this conclusion received further confirmation.

2. THE RESULTS OF MY METHOD.

With the determination of the fact that doses of more than 20 milligrams, if injected intravenously, produce serious effects in young cattle, and that doses exceeding 50 milligrams may lead to a fatal result, the question arose whether or not it was possible to secure protection in young cattle against large doses of the virus, under the now generally known principle of isopathic immunization. That this is the case appears from the protocols which I have published in my book heretofore cited, to which I will add several other protocols in the next

number of my "Beiträge zur Experimentellen Therapie" and which will show, that in a relatively short period the doses can be increased to 0.3 gr. without thereby causing injurious effects.

Now, in what manner do cattle which have been previously treated with protective inoculations, respond when infected with a bovine virus, which, since Koch's communication to the London Congress we know, has also in laboratory experiments the power, to produce a fatal effect?

This practically important question can be answered by stating that with the increased resistance against infection with dried human tubercle bacilli (used for protective inoculation) a like increased resistance develops against infection with bovine virus, for the proof of which I can not only refer to my already published protocols, but also to new experiments which I expect to make public before the close of the present year.

The animals which have been treated by protective inoculations have in the meantime also been exposed to the danger of natural (epidemiologic) tuberculosis infection, without thus far showing any signs of having acquired the disease, which not only justified me, but also made it appear a duty to begin the trial of immunization for the restriction of bovine tuberculosis for economic purposes.

In closing I will, however, not omit to point out again that primarily it has been my chief purpose to settle the question as to the necessary minimum dose which will protect young animals against the danger of natural (epidemiologic) infection.

Should it appear that animals which received but one protective inoculation, are still liable to become tuberculous, then the first inoculation must be followed by a second one, and I do not positively assert that the primary inoculation with dried human tubercle bacilli may not need to be followed by an inoculation with modified bovine virus. All this, however, I am unable to determine at this time, neither am I in favor of extensive application of this method of Jennerization until it has been definitely elaborated and confirmed. On the contrary, I shall give my aid in such trials only to experienced veterinarians who have made themselves familiar with the scientific basis of the procedure in my laboratory and who will undertake to follow my methods and give exact reports of their results.

Marburg, Germany, Sept. 18, 1902.

SUPPLEMENT TO THE JOURNAL OF TUBERCULOSIS.

In this part the whole subject of Pulmonary Tuberculosis will be covered by a continued series of articles written by Dr. Karl von Ruck to appear in the following order:

Article I.—The Cause of Tuberculosis, and The Conditions Which Predispose to its Acquirement. Article II.—The Prevention of Tuberculosis. Article III.—The Pathology and Symptomatology of Pulmonary Tuberculosis. Article IV.—The Diagnosis of Pulmonary Tuberculosis. Article V.—The Prognosis of Pulmonary Tuberculosis. Article VI.—The Treatment of Tuberculosis, Dietetic, Hygienic and Symptomatic. Article VII.—The Climatic Treatment. Article VIII.—The Specific Treatment. Article IX—Laryngeal Tuberculosis, its Diagnosis and Treatment. Article X.—Institutions for the Treatment of Pulmonary Tuberculosis.

THE CLIMATIC TREATMENT OF TUBERCULOSIS.

THE INFLUENCE OF CLIMATE IN THE TREATMENT OF PULMONARY TUBERCULOSIS.

[CONTINUED FROM PAGE 320.]

The advent of tuberculosis among the inhabitants of the altitude resorts dispelled the idea of an *immune climate*; the very dry air was found to be a source of irritation, especially to the upper air passages, the difference in numbers of bacteria in the air was found to be largely due to harmless saprophytes and did not seem to protect patients against infection of their necrotic lung lesions with the pus germs. Pneumonias appeared to be even more frequent than at lower levels; in short, only patients who had but slight or initial changes or latent lung lesions appeared to do well. With all others the altitude, and all that pertained to it in the way of supposed advantages, was found powerless to change the course of the disease to a more favorable one.

Even the peculiar phenomenon of the increase in red blood cells has since been questioned. The investigations of Schroeder, Gottstein, and Meissen, within the last three or four years, tend to show that it is more apparent than real, depending on error due to diminished air pressure upon the cover-glass of the blood chamber in which the count is made.

To reconcile these apparently contradictory facts by a satisfactory explanation of them, it is essential that the clinical material should also be taken into consideration and that the pathology of tuberculosis in the individual patient should not be lost sight of. To do this we may well remember that the pathologic changes in tuberculosis of the lung comprise variations from comparatively simple to the most complex alterations, and that to these the entire organism shows reaction in disturbed

and perverted functions and in degrees that vary with existing lung lesions, as well as with the individual constitution and resistance of the patient.

As to the therapeutic influence of climate in tuberculosis, there is no occasion to doubt the empirical observations made during centuries that have passed, and any attempt to ignore this influence or to deny certain benefits derived from it will only add more confusion. There are certain elementary facts, also, of which there can be no reasonable doubt, both as to climatic influences and as to the disease under consideration, and these elementary facts must be applied on both sides. In attempting this, I desire to be strictly conservative by stating:

First: *Change from an accustomed climatic environment to a different one, and especially from one that is damp, chilly and cloudy, to one that is warm and sunny has the same exhilarating influence that we observe in ourselves without change of locality, when, after a prolonged period of bad weather, a change to pleasant weather and to sunshine occurs.*

To such a change, react those who are well and also those who are not severely ill, but in the case of a patient who has advanced in his disease to degrees that his suffering and exhaustion are such that he can think only of himself, or can take no notice of, or interest in his environment, the change is non-effective, and so far as the effort in making it calls upon his strength and endurance, it is harmful.

Let us illustrate this proposition, simple as it is, and take, on the one hand, a patient who has an affection of one or even both upper lobes, which is but slowly progressing or perhaps is stationary and in which the pathologic changes have not reached the stage of softening and excavation; such a patient is practically free from fever, as well as from other striking symptoms; he may be easily fatigued and may have lost some weight, but he is physically in fair condition. To him the change is agreeable; he is pleased with the better state of the weather; he notes with interest things he observes, especially the things which are different from those he was accustomed to at home; he tells you of it, and he evidently feels better. That the influence is largely mental cannot be doubted, but the result is that under the change he reacts to his new environment, he eats better and sleeps better, and it has done him good.

Take another case, one that has softening in a tuberculous area, perhaps with a pleurisy that causes pain on deep inspiration; this patient has fever, likely to begin with a chill, he feels badly, tired and

weary, coughs, lacks in appetite, nothing satisfies him; he fails to take interest in his new environment. All he wants is to be free from his disagreeable symptoms, and these will not subside; until they do, he cannot react to the change. The result is that the effort of travel has fatigued him, has perhaps increased his symptoms, and his expectations having not been realized, he suffers the depression incident to his disappointment.

Second: *Cool, dry air is invigorating, and hot, moist air is enervating and exhausting.*

This is also verified in the experience of those who are healthy as of those who are ill. For the pulmonary invalid who is to gain an advantage by a change to a cool, invigorating climate, we must, however, condition that the air be not so cold that he is restricted in his out-of-door life, and that he must have a sufficiently active circulation that the cool, dry air will appear grateful to his sensations.

Third: *The breathing of pure air in the sense that it is comparatively free from organic and inorganic matter is better for healthy as well as for sick people, than is the breathing of foul air, or air which contains dust and dirt in suspension.*

Applying this proposition to the pulmonary invalid, I expect no disagreement by asserting that air laden with fine sand, dust and dirt is the more objectionable because of local irritation in the lungs which follows, and which is likely to be more detrimental in all those who have more or less bronchial catarrh and on that account are proportionally deficient in the mechanism for prompt expulsion, the ciliated epithelium being impaired or absent from affected mucous surfaces.

In considering climatic resorts in regard to their advantages in respect to purity of the air, there can be no objection to the claim that the air is purer in the open country than in crowded cities and that this difference is greater in all respects in regions having forest covered surfaces and in which human activities as to manufacturing and agriculture are greatly restricted or absent, than in densely populated manufacturing districts and especially in large cities.

That, therefore, the high altitude regions which are sparsely or not at all populated have a decided advantage, goes without saying, but that these advantages are more or less modified and are not available to the theoretical degree becomes apparent when we remember that in such remote localities the average pulmonary invalid will not find the conditions highly essential to his recovery, and that, after all, he must seek more or less populous towns in such regions in order to have the dietetic and professional care and environment which he requires. In

some barren and arid regions which also have certain climatic advantages, the continued presence of a large amount of inorganic matter in the air in the form of dust and fine sand, is an additional disadvantage, especially to those who have advanced beyond the early stage of the disease.

Fourth: *With intact vascular channels between right and left heart the peripheral circulation is increased in proportion as the atmospheric pressure is diminished.*

At elevations of great height, 10,000 feet and over for instance, the congestion of surfaces exposed to the air rarification becomes so great that anaemia of internal organs may supervene and haemorrhages may occur from capillaries of mucous membranes. The influence of the effect of different degrees of rarification of the air may be taken advantage of in tuberculosis of internal organs as well as of the respiratory surfaces and integument, the benefit derivable, depending upon the action of relative degrees of internal anaemia or external congestion upon the pathologic alterations existing in the respective parts.

In estimating this benefit in pulmonary tuberculosis, we must take into consideration the degree of obstruction caused by the pathologic changes in the lung. In proportion to their extent the sum total of the vascular channels which lie between the right and left side of the heart is diminished, and as a result, the vascular pressure in the pulmonary artery is increased, so long as the right ventricle is competent in its power. Under greater degrees of obstruction or greater degrees of rarification or both, active pulmonary congestion or rupture of branches of the pulmonary artery in the diseased lung portions is favored if the right heart is competent to maintain the pressure; if the latter fails, venous congestion in parts and organs back of the right ventricle must follow, while at the same time heart-strain is induced. We see, therefore, that in employing high altitude effects in pulmonary tuberculosis, we may obtain varying results, according to the pathologic changes that happen to exist in the individual case, and according to the integrity of the right ventricle and pulmonary semilunar valves. What must be guarded against is strain of the right ventricle and congestion of the pulmonary tissues. In this respect the effect of considerable degrees of altitude is therefore the same as we observe from physical exercise which may induce like conditions. When altitude and exercise are combined patients who have considerable vascular obstruction in their lungs are limited in a greater degree as concerns the latter at elevated regions, than at the sea-level.

Fifth: *A relatively dry locality is better for the pulmonary invalid than a damp or moist one.*

This proposition will also require no defence. While I would not seek to establish a direct influence upon the local lung disease I see its value chiefly in the more rapid cutaneous evaporation and through this, in a diminished liability to contract colds and catarrhal inflammation of the air passages, while at the same time the patient's comfort is greatly enhanced, and in addition, in the fact that influenza is favored in its occurrence by moisture. Those who understand the development of pulmonary *phthisis* know very well, if we understand by it the initiation of destructive processes in the lung, that the phthisical stage is preceded by another, namely the tuberculization of certain portions of the lung, and that in the vast majority of cases in which the tuberculous affection is limited to a lobe or portion of a lobe, the natural course is to a period of latency of longer or shorter duration. They also know that this latent tuberculous deposit is liable to renewed inflammation, and that when this occurs, softening and excavation, i. e., the beginning of pulmonary phthisis is the usual result. If by any manner of means we could protect those who have latent tuberculous deposits in their lungs against renewed inflammation in that part of the lung where such a deposit is situated, the cases of phthisis would be comparatively few. In our efforts to do this we must seek to recognize the causes that are responsible, and which are now very well understood. A study of the clinical history of a material which amounts to 3,500 cases from my own practice shows that in 75 per cent. the first evidence of the beginning phthisis has been immediately preceded by incidental inflammation of the air passages, occurring in the course of ordinary good health, or in connection with acute disease. The causes of incidental inflammations were assigned to acute bronchitis ("taking cold") in 29 per cent.; to influenza (grippe) in 47 per cent.; to pneumonia in 12.5 per cent.; to typhoid fever in 10 per cent.; whooping cough, diphtheria, smallpox, quinzy and scarlet fever in 2.5 per cent. These statistics agree with others that are chiefly obtained from adults, and they show that bronchitis from ordinary colds, is responsible for the development of phthisis in tuberculous subjects in nearly one-third of all cases; and if we include influenza these two causes appear in three-fourths of all cases to have initiated the phthisical stage. My statistical records bear me out in the statement, further, that in a very large proportion of cases of early phthisis the disease does not progress continuously to a fatal issue, but on the contrary, an arrestment or at least a marked degree of amelioration follows evacuation of the first abscess cavity, and that the causes for renewal of disease and relapses are often the same that excite the phthisical process in the first place.

If I am right in these statements, and if our views in regard to dampness of soil and air as causative factors in the contraction of catarrhal inflammation are correct, then it follows that, other things being equal, a relatively dry climate protects to a certain extent against the development of phthisis in cases which have latent tuberculous deposits in their lungs, and that in the established disease it becomes valuable in the treatment thereof by diminishing in a like degree the occurrence of relapses; in other words, the patient has a better chance for recovery in a dry climate because relapses are less frequently induced.

The study of climatology having established the fact that elevated regions have, as a rule, less relative humidity than low sea coast localities, we see from clinical experience in such localities, that many cases in the early stages of tuberculosis—that is in the formative and latent stages—continue in good health in high altitudes and dry localities as long as they remain there under otherwise favorable hygienic and dietetic conditions, and that in the early stages of developed phthisis in which the disease is limited to a small area, more arrestments and recoveries obtain than in regions where dampness of soil and air are liable, through induction of incidental inflammation, to interrupt the favorable course of the disease.

Sixth: *Sunlight is essential to health and life through its influence upon the vegetative processes.*

This observation is so common and universal that, like the preceding proposition, there is no reasonable ground for its denial. The influence of out-of-door life which is universally recognized as conducive to the best state of nutrition and physical well-being is, in my opinion, due to a much greater degree to the simultaneous exposure to sunlight than to a difference in quality of the air, although I would by no means underestimate the value of purity of the latter. Total absence of light means perversion of the nutritive functions, physical deterioration, and ultimately premature death. Indoor life is detrimental to the degree that the light is diminished or withheld, a fact which we have fully recognized, in considering indoor occupation, especially in dark rooms, as an important predisposing factor to the acquirement of infection and to an unfavorable progress of the disease.

If we again examine the climatic features of elevated localities or of low regions which have shown satisfactory results in the treatment of phthisis, we find them to be, in either case, particularly those where out-of-door life is invited by a favorable state of the weather, temperature and sunshine. If we need further evidence, we have it abundantly in the results obtained in all institutions for the treatment of pulmonary tuberculosis, no matter where located, in which out-of-door life, that is to say, exposure to sunlight, is a feature of the treatment.

In accepting these general propositions as to the treatment of tuberculosis, we can readily see that even under the most favorable combination of the advantages obtainable, the effect of climate upon the course of pulmonary tuberculosis is not exerted directly upon the disease itself, and that there really is no immune or curative climate. At the same time we can appreciate that in suitably selected cases these influences can become most important aids both in prophylaxis and in treatment.

This brings us to the selection of cases for climatic treatment. In view of what I have said, and in the light of clinical experience at hand, we can claim:—

1st. That the removal to a climate having the advantages considered in the preceding propositions, is of benefit to all those who in any sense are predisposed to the acquirement of infection, so long as they avoid intimate contact with careless patients who promiscuously discharge infectious secretions.

2d. That such removal is also of advantage to all those who are already infected, but whose tuberculous affections are either very recent, or have become latent.

3rd. That in more advanced stages such a climate becomes valuable in limiting relapses due to catarrhal inflammations, and in favoring nutrition by the out-of-door life it allows under the influence of favorable conditions of temperature and sunlight.

In either of the first two classes the climate is employed from a prophylactic standpoint, against infection in the first and against the occurrence of destructive changes—that is against the development of phthisis—in the second. A like object in the way of prevention is sought and often accomplished in cases of the third class which have already passed through that early stage of phthisis in which the first destructive changes occur, but in which active symptoms have subsided. In such cases a favorable climate affords good prospects that the formed cavity will cease to secrete and will heal out, and that other existing tuberculous areas which have not as yet broken down will continue latent, because the chances for incidental local inflammation are much less, and the general influence upon nutrition increases the patient's power of resistance.

In the third class of cases suitable for climatic treatment, I include those which after reaching the open stage of phthisis, that is to say, having established an outlet from the formed cavity into a bronchus, show moderate temperature elevations to between 100 and 101° F.

It is quite a different proposition when we propose climatic treatment for cases with active, progressive and acute phthisical processes,

and to send such patients away from their homes, involves great responsibility on account of the uncertainties as to the future course of the disease. When this must, nevertheless be considered, the attending physician should not lose sight of the fact that climate can in no wise remove or even modify the existing pathological changes in the lungs or elsewhere, excepting through the indirect influences already enumerated, which render the reparative efforts of nature less liable to be interrupted, on the one hand, and which aid the general metabolic processes on the other. The latter, however, are only to be improved when the patient can take advantage of the out of door life and sunlight which the selected locality affords, and such improvement usually fails to manifest itself appreciably until the acute symptoms due to local softening, suppuration or inflammation have subsided.

Here may also be included a class of patients in whom phthisis is of a pneumonic type from the start, or in whom acute pneumonic inflammation has become a complication from aspiration of sputum, or in connection with grippe, bronchitis, etc., and finally patients who for the time have acute pleurisy. In all such cases I would strongly urge delay in seeking the advantages of any climate, but more particularly would I caution against removal to distant localities, whereby the incidents of the journey, through fatigue and exposure, may greatly diminish the still existing prospects. Such patients are, as a rule, confined to bed, or ought to be so confined for their best interests, and I cannot see any real advantage to be derived from their removal to a better climate where the same course of management must be adopted until the acute symptoms have subsided. Since out of door life is out of the question in either place, and since the danger of renewed inflammation through exposure to prevailing conditions of bad weather practically does not exist with bed patients, it would seem the wisest plan to await the termination of the acute symptoms, and to consider the prospects of climatic benefit in the light of the condition of the patient as found at that time.

Patients who at the termination of acute processes arrive at this stage greatly emaciated and exhausted, should be tested as to their recuperative powers at home where through proper feeding and hygienic measures, amelioration will show itself also, if it is still to be obtained. When this improvement has occurred to a degree that the patient can make the journey to a climatic resort with comfort and without danger of seriously injurious fatigue, it is time enough to send him.

In considering complications on the part of the digestive organs, lack of appetite in the absence of actual gastro-intestinal disease is not

a contraindication; on the contrary, when the anorexia is not caused by fever, such patients, as a rule, show prompt improvement in this respect in moderate and high altitudes.

Although otherwise eligible, patients who have had recent haemorrhages, should not be started on a journey to climatic resorts until bloody expectoration has been absent for a week or ten days, and high altitude resorts should be avoided even if there is no other contraindication.

Excluding all such cases as have been indicated, at least for the time being, as suitable for climatic treatment, the physician should still take into consideration the general state of nutrition and strength as well as the extent of the local lung disease and the complications which may be present in all those who might otherwise be classed as suitable cases, and here he will find again quite a number in which the removal to climatic resorts had better be delayed.

As of doubtful utility as regards probably lasting benefits, I consider climatic treatment in that stage of the disease in which large suppurating cavities are present or destructive changes involve large areas, especially when such advanced lesions are manifest in both lungs, although active only in the last involved lobe or side.

Another class of patients who should not be sent away from home is constituted by those who in spite of drinking freely of hot water or who under the use of mild diuretics, continue to show a marked diazo reaction in the urine; also those who suffer from persistent diarrhoea under proper dietetic regimen, and who fail to obtain relief from suitable medical treatment, even if the general condition is still fair, and although none of the acute processes mentioned above may be in evidence.

Extensive ulcerative processes or extensive infiltrations in the larynx that cause painful deglutition are so rarely recovered from or even materially improved that climatic treatment is of doubtful advantage beyond the possible prospect of prolonging life. Only when skilful local treatment is not available at home, and when the lung affection is limited and the general nutrition and strength of the patient are still satisfacory, and when such patients may be placed under the care of a competent laryngologist, at the selected resort is removal to a favorable climate to be considered.

With no greater expectations than I have enumerated in the earlier part of the consideration of climatic influences, and with a selection of cases as here indicated, I am sure, that no serious disappointments will follow its employment, always providing that the patient is properly

cared for and advised at the climatic station to which he resorts, and that he is conscientious in following the advice he receives.

The results that may be expected are, in cases of recent and circumscribed tuberculous invasions of the lung, and in cases presenting latent processes of like character, that the latent period may be continued indefinitely until, after a considerable number of years, an actual recovery will result through gradual fibroid transformation of recent tubercles and encapsulation of caseous nodules and areas. During this prolonged period the patient may apparently enjoy good health, and may lead a useful and comparatively active life, which, however, should be in the open air as much as possible and guarded against all excesses, physical or mental, as well as against undue exposure. Relapses and new accessions will, however, occur for the simple reason that climate, however favorable, is not unconditionally protective against them, inasmuch as it cannot save the patient from accidental mishaps or from results of willful disregard of the observation of conditions that are essential, and which many patients either fail to observe at all, or are only too ready to interrupt, in an optimistic belief, that subsidence of symptoms is equivalent to an actual cure.*

*Henceforth the Supplement will be discontinued as a department of the Journal and the series of articles by Dr. Karl von Ruck will be continued in the Original columns.